AIR MINISTRY.

PROCEEDINGS

OF THE

THIRD AIR CONFERENCE,

HELD ON

6th and 7th February, 1923.

Presented to Parliament by Command of His Majesty.

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AIR CONFERENCE, 1923.

REPORT OF PROCEEDINGS of the THIRD AIR CONFERENCE, held on the 6th and 7th February, 1923, in the Council Chamber of the City of London at the Guildhall, by kind permission of the Lord Mayor and Corporation.

TUESDAY, 6th FEBRUARY.

MORNING SESSION.

The Conference was opened by the Rt. Hon. the LORD MAYOR OF LONDON, ALDERMAN E. C. MOORE, who spoke as follows:—

The LORD MAYOR: Sir Samuel Hoare and Gentlemen: It gives me great pleasure, on behalf of the Corporation of London, to extend to you once again a cordial welcome to the Guildhall where both of your previous Conferences have been held with, I am told, much success. Having glanced at the outline of the papers which are about to be read to you, I rejoice to observe the noteworthy progress in air transport which has been made and recorded since you last met here, and the auguries of important future developments both in practical appliances and scientific research and experiment. The City of London is keenly alive to the vital importance of air transport, both military and civil, to the prosperity, possibly even to the existence of, the Empire, and I feel certain that, in its name, I may confidently assure the Secretary of State for Air of the support of the City in every effort which may be necessary to ensure that end.

The future of civil aviation is a matter which especially interests me. In my own time the famous annual pageant known as the Lord Mayor's Show has been held first on the water and then on the land. I may not live to see it, but some of my successors may experience a Lord Mayor's Show in the air. I thank you for inviting me to be present and I sincerely trust that the result of your two days' deliberations may be of advantage to the great and important science in which, as an Empire and as individuals, we are all so immensely interested.

I will now vacate the Chair to Sir Samuel Hoare, who will preside over your deliberations.

The Chair was accordingly taken by Lt.-Col. the Rt. Hon. Sir SAMUEL HOARE, Bt., C.M.G., M.P., Secretary of State for Air.

The CHAIRMAN (The Secretary of State for Air): Gentlemen, our first pleasure and duty this morning is to express to the Lord Mayor our thanks for his presence here to-day. This Conference is an annual event and it is particularly agreeable that year after year the Lord Mayor should offer us the hospitality of this historic hall for our deliberations. I feel sure, therefore, that you would wish me to convey to his Lordship our grateful thanks both for the use of the Guildhall

and for his presence in coming to open the proceedings of the Conference.

Well, Gentlemen, as far as I am concerned, my first word is a word of welcome to all of you who are present at the Conference. I do not think there could be an assembly more representative of the various British interests in civil aviation. The science of the air, the industry of the air, the skill of the air, the warfare of the air, indeed every phase of the air has its expert here to-day. Gentlemen, you will not be surprised if in the presence of all you experts a mere layman like myself speaks with some diffidence.

I have now been in office for three months and I need a much longer apprenticeship than these few weeks before I can say anything of real value upon the subjects that we are here to discuss to-day and to-morrow. I can only say that since I have been in office I have been concentrating my whole attention day by day upon the problems connected with my Ministry, and I can tell you that if I find many of them very difficult I have found all of them overwhelmingly interesting. It is a remarkable experience for a man who has hitherto had no connection with the air to be suddenly transplanted from the humdrum routine of mundane business and politics to the attractive and sometimes bewildering heights of the air.

In these circumstances the only value that my observations can have comes from the fact that I have studied the problem of military and civil aviation as far as I have been able, with a completely impartial mind.

Let me, if you will allow me, in a few sentences give you my first impressions, and let me make the proviso that whilst first impressions are sometimes right, I must keep myself free to modify them if you or anyone else convinces me that they are wrong.

I am first of all struck by the fact, a very obvious fact, that there are at present two very great obstacles to the progress of civil aviation.

First of all, there is the obstacle that is caused by the shortage of money and, secondly, there is the obstacle that is caused by the after-war confusion of the world. Let me say a word about each of these very obvious obstacles in our path.

I take, first of all, the money question. It is indeed a tragedy that just at the moment when we wish to embark upon wide and wise schemes of aviation development, we have on the one hand to cut our national expenditure down to a bare subsistence level, and, on the other hand, we have none of those ample funds that we could formerly have drawn from private capital for enterprise and private adventure.

It is not necessary, least of all in the City of London, to say that as a nation and as private individuals we are very hard up. As a nation we are rightly looking for diminution and not increases in national expenditure, and as private individuals, who are feeling very hard up, we hesitate to invest our money unless we can see a quick and certain return.

In saying this I am stating an obvious fact; and I am stating an obvious fact when I say, further, that it is very difficult to develop aviation without considerable public and private expenditure, and that at the moment it is not always easy to find the money. So much for the first of our obstacles.

Then there is the great difficulty of developing and organising civil aviation when the world is still living in an atmosphere of war. Observe, for instance, the practical difficulty that arises in arranging air routes when you never know from month to month whether the

aerodromes of this or that country will be open to you, or whether this or that country on the Continent will be in a state of war or peace.

Observe, however, what is more important, that so long as we are living in this atmosphere of war and as long as the world is in this state of confusion and uncertainty, military aviation must have the first and principal call upon the nation's purse.

Personally I regard the huge expenditure of the world upon soldiers and ships and armies and fleets and air squadrons as an intolerable burden upon trade and industry and, indeed, as an outrage upon Christian civilization. But until there is a new spirit in the world and until we have got out of this atmosphere of wars and rumours of wars, we cannot afford to let our air defences fall below the Empire's needs. This is not the time for me to discuss the very urgent question of what our air defences ought to be. Permit me only to say that at the present moment they are very low as compared with other great powers, and there does not seem to me to be the least possibility at the moment of any reduction. This being so, it is inevitable that, whether we like it or not, the greater part of the national expenditure upon air must for the present go to our military commitments of home and imperial defence.

Gentlemen, I put before you these two difficulties, not in any way to depress you, or to suggest that you should lose heart in the development of civil aviation, but to emphasize to you the limitations within which I am working. Criticise as you will the Government's air policy, or want of air policy, but remember always the two conditions under which we are working; the first that there is very little money to spend and the second that the world is still in a state of confusion and unrest.

But I do not wish to leave the question at this point, for if I did you would say, and you would say rightly, that I had merely stated two evident truths,—that I had no policy and that neither this nor any other Air Conference was any good. If I gave this impression I should be entirely misrepresenting my own position. I will tell you quite frankly that so far as I am able, working within the two limitations that I have just outlined to you, I am determined to try to develop a consistent civil aviation policy. So far am I from allowing civil aviation to collapse that I have for weeks past been studying various schemes for setting it in the way of organic development. I cannot at present go into detail upon these questions, and I tell you frankly that I have not yet had time fully to make up my mind nor to convince my colleagues in the Government. I can only suggest to you the lines upon which my thought is travelling.

I take first of all the basic question of any aviation development, the question of research. In a field so unsurveyed as the air, research is vitally important, and it is all the more important in a country where aircraft construction is not on a big scale. Sir Geoffrey Salmond will describe to you in detail the progress that we are making in the matter of research. I admit that owing to financial difficulties it is not as great as we should like, but I can assure you that I realize its importance and that I am only too anxious to see further developments, whether it be in civil machines of which, I understand, eight types are already under construction, or engines, or fuel, or questions of reliability and low running cost.

Next I come to the aircraft industry. The aircraft industry is a small industry in point of numbers, but it is a vital industry and contains

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brains and hands that if they were once lost might never be recovered. I have had the pleasure of visiting one or two aircraft works and I hope to visit several more in the near future, and I own that I have been immensely struck by the very high standard of inventive ingenuity and technical craftsmanship that I saw there. It would be a calamity not only to civil aviation but to all aviation if the British aircraft industry came to an end. My first act as Secretary of State for Air was to obtain the permission of the Cabinet to go on with the Home Defence expansion scheme, and I hope that this expansion will not only strengthen our air defences but also will give, at the same time, some stimulus, and a very justifiable stimulus, to the British aircraft industry. I will ask my friends in the industry to regard that, my first act as Secretary of State for Air, as symptomatic of the fact that I should look upon the disappearance of that industry as a national calamity.

Secondly, I have been considering very carefully the many schemes that have been in operation or are suggested to be in operation for the various cross-Channel services. As General Brancker is going into this question in detail, I will only say that I am anxious to base my policy upon certain broad foundations. In the first place, there should be a sufficiently long period of contract for the operating company or companies as will enable them to sink capital and develop their routes. Then there should be as little interference on the part of the Government as is possible under a subsidy system. I want to see the operating organization work out its own salvation with an incentive to develop along its own lines. Subsidies are only justifiable if, after a limited interval, they enable an industry to find its feet. They cannot be justified if they give only outdoor relief to companies but no incentive to develop. And may I add in this connection that no system of subsidies should be so arranged as to hamper the very useful work that is now being done, whether by air-taxi journeys or by certain small unsubsidised enterprises.

Next, I am very anxious to see a start made with an Imperial air route whether it be by aeroplane or whether it be by airship. Commander Burney, whose name is very well known in this connection, is going to put before you the case for the airship. The Civil Aviation Advisory Board—to whose members I am very much indebted for their useful report—have recently been considering the question from the aeroplane side of it, and I would commend to the attention of any of you who have not read their Report,* the very valuable recommendations they have made on the subject. When that start can be made, and how, I cannot at present say. The decision does not altogether rest with me, for it is a matter for the Cabinet and, indeed, for the Dominions as well. I can, however, state that I should like to see a beginning made with such a route. Even to-day we claim to have made a small experiment in this direction with the Cairo to Baghdad fortnightly service. The service is frankly a military service, and it cannot therefore be judged by commercial standards, but it is significant that 28 per cent. of the mail from Cairo to Baghdad and 19 per cent. of the mail from Baghdad to Cairo is already being carried by it, that the journeys are made with a remarkable regularity and that they take two days instead of 21 to 23 from Cairo to Baghdad. How useful such a route can be politically is shown by the fact that when the British Government wished the other day to consult Sir Percy Scott upon

* Cmd. 1739; His Majesty's Stationery Office, 1922; 1*s.* net.

certain urgent questions connected with the future of Iraq, he was able to arrive in London in nine days instead of 27 to 30.

Well, gentlemen, I have given you a sketch and a very rough one, of the lines upon which my mind is working. You will be able to fill in much of the detail in your deliberations to-day and to-morrow. You will be able to give me much valuable information. You will be able to give me many suggestions.

But most of all you will be able to instruct public opinion outside. For it seems to me, coming in as a new man with no preconceived ideas or theories, that what is chiefly wanted with air questions is an instructed public opinion. We do not want air questions discussed in the terminology of stunts. We do not want air questions discussed in an atmosphere that jumps from an optimism that affirms that aviation can do everything, to a pessimism that denies that it can do anything. You want to get down from headlines and wild promises to an atmosphere of quiet and instructed discussion and development.

You, gentlemen, will be helping to this end, and on this account in wishing you welcome I can assure you that your deliberations will be of great value not only to the experts who are gathered together to-day but to the wider public in the world outside.

I have finished what I intended to say and I ask you now to listen to the Director of Civil Aviation, Sir Sefton Brancker, who will proceed to read his Paper. Before I call upon him, may I suggest that it would probably be for the convenience of members if last year's precedent were followed, and those who desire to take part in the discussion would send up their names, either to-day or to-morrow, stating the subjects upon which they wish to speak and the organisations, if any, that they represent.

THE POSITION OF AIR TRANSPORT TO-DAY.

Major-General Sir W. Sefton Brancker, K.C.B., A.F.C., Director of Civil Aviation, Air Ministry : Mr. Chairman, my Lords, and Gentlemen : My task to-day is a straightforward one. I have to describe the progress of civil aviation generally since we met at the Guildhall this time last year ; I have to answer, so far as I am able, the criticisms put forward at that Conference ; and I have to define our present position and communicate some of our intentions in the immediate future.

I have heard my position here to-day described as piquant. Last year I was a violent and indiscreet critic sitting down there in the body of the hall. To-day I am a very cautious and discreet Government servant, and I hope you will remember that. I wish I was down there with you on this occasion because there are some things I should like to say. But I will quote what Lord Gorell has said so charmingly in to-day's *Morning Post :* "This morning Major-General Sir Sefton Brancker will undertake the task which last year fell to me to review the position of air transport generally. . . . He will have the pleasure of replying to some extent to the trenchant criticisms he levelled at the Air Ministry a year ago, and the interest of finding himself not the arrow impetuously launched but the target at whom others may shoot."

THE INTERNATIONAL COMMISSION FOR AIR NAVIGATION.

I will first deal with the doings of the International Commission for Air Navigation.

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The International Convention for the Regulation of Aerial Navigation was drawn up under the auspices of the Treaty of Versailles. Its objects were to facilitate air transport between States who were signatories to the Convention by the introduction of uniform systems of signals and maps, by the supply of meteorological information and so forth, and to ensure the proper standard of safety and reliability throughout the air transport activities of those signatories.

The Convention was signed by twenty-one States, but so far has only been ratified by the nine following States :—

The British Empire.	Japan.
Belgium.	Portugal.
Bolivia.	Jugo-Slavia.
France.	Siam.
Greece.	

Persia has also since adhered to the Convention, and is now represented on the Commission.

The Commission first met in Paris last July and it was there decided that it should meet three times a year at the capital of one of the signatories wherever most convenient. Its second session was held in London during October, and its next will be in Brussels at the end of February. Its meetings so far have been remarkable for the cordiality of the relations between all nations represented; there has not been a single point of serious difference of opinion, and in consequence very considerable progress has been made. I would like to say that the French and ourselves have been absolutely hand in hand over this agreement in spite of the various troubles which have arisen outside of aviation.

The bulk of the work has been technical and has dealt with provisions of safety, airworthiness certificates, licensing of pilots, organisation of wireless and meteorological information, medical regulations and similar details which I will not deal with here. It has also dealt with two questions of policy which have a considerable bearing on the future of air transport.

Some of the non-signatory States had several criticisms to make against the Convention as it stood, particularly with regard to two Articles, Article 5 and Article 34.

Article 5 as it stood made it impossible for a contracting State to allow flight above its territory of aircraft belonging to a non-contracting State, except by means of a special and temporary authorisation. This restriction necessarily hampered the development of European air services. The British representatives were the first to suggest that this Article must be modified and the French representatives accepted this suggestion with alacrity. An amended wording of Article 5 was drawn up in July, and finally approved at the London meeting in October. By the new Article 5 contracting States have freedom to make agreements with non-contracting States without let or hindrance, so long as these special agreements do not infringe the rights of the contracting States and do not clash with the rules laid down in the Convention or its Annexes.

The amendment of Article 5 was drawn up in the form of a Protocol, which is now in process of being ratified, but ratification, of course, takes time, as it is necessary to obtain the agreement of countries at great distances, such as Japan, Persia and New Zealand.

Article 34 relates to the International Commission for Air Navigation. Under this article the voting power of members of the Commission is such that the five great allies, France, Italy, United States,

Japan and Great Britain if voting together will always have a majority. The present representation gives France, Japan and Great Britain two votes apiece. The small nations naturally take exception to this, and this Article has undoubtedly been a deterrent to the late neutral nations from asking for membership ; they plead that it smacks too much of the Great War and that they cannot agree to the principle of the old allies always being certain of a majority. This question has also been considered and it is generally agreed that something must be done to modify Article 34. The exact form that this modification will take is an extremely difficult question and will undoubtedly demand considerable discussion before anything can be settled.

Actually, the fact that two of the great allies—the United States and Italy—have not yet ratified makes the assured majority of the great allies inoperative. I believe that Italy and Czecho-Slovakia are about to ratify and that the United States are also considering the question seriously.

It is of urgent importance for the future of air transport that all nations, including our late enemies, should sign the International Convention, as it is only by its means that common rules of navigation, lighting, signalling, and other regulations for the safety of aircraft and personnel can be extended throughout the world, and it is obvious that the creation of two or three sets of different rules in different parts of the globe would lead to needless trouble, delay and expense and danger in the future.

The International Commission has so far been an unqualified success and personally I have very great hopes that it will develop into a strong factor towards maintaining the peace of Europe in the future.

There is a *camaraderie* in the air that is really beginning to eliminate national prejudices. It is obvious that a form of transport that is going to carry you through clean sweet air to the heart of your neighbour's country is going to create quite a different outlook towards that neighbour than could have ever existed when we depended on the limited, uncomfortable, disjointed and inconvenient method of progress by train and boat.

HISTORY OF AIR TRANSPORT DURING THE PAST YEAR.

(i) *Subsidised Services.*

I will begin by describing the events which have occurred in relation to the cross-Channel services during 1922.

During 1921 a sum of £600,000 had been allocated by the Government to cover financial assistance to the cross-Channel air services for a period of three years commencing on April 1st, 1921. In February, 1922, when we were here last a new system of subsidy had just been finally decided upon. During the previous year, since February, 1921, a temporary scheme of limited financial assistance to two air transport companies flying from London to Paris had been in operation.

This temporary scheme guaranteed that the Government would pay the two companies a sum which would give them a 10 per cent. profit on their actual traffic receipts after the accounts had been made up. A payment on account of £75 per flight was made to approved services up to a limit of about £43,000 to each firm. This system tended to encourage extravagance and to limit flying, but it kept two companies—Messrs. Handley Page and Messrs. S. Instone & Co. alive,

whilst the policy of the future was considered. During this period the French had made great strides in obtaining traffic, and whilst we had carried over 90 per cent. of the traffic available in 1920, in 1921 we carried only 55 per cent.

The new subsidy scheme which had just been decided upon at the time of our meeting last year catered for three rival companies flying to Paris, and one company to Brussels. The Daimler Airways Company had risen from the ashes of the old Aircraft Transport and Travel Company, and had been approved by the Air Ministry for the Paris route as well as Instone and Handley Page. The Instone Air Line had also been allotted the Brussels route in addition to Paris. The subsidy payments allowed were divided into two categories : a 25 per cent. bonus on the rates charged for the passengers and goods carried; then for Paris a capitation grant of £3 per head per passenger and 3*d.* per lb. of goods. The scheme also sanctioned the provision by Government of half the purchase price of their fleets to the operating firms on a hire purchase basis, $2\frac{1}{2}$ per cent. of the purchase price being paid by the companies monthly, the aircraft becoming their property after 30 months; thus they obtained half their fleet at rather less than 75 per cent. of its total cost by easy payments; Government also paid 50 per cent. on insurance premiums up to 10 per cent.; for Brussels the capitation grant was calculated on a slightly different system. On paper this scheme looked wonderful; in practice it did not work satisfactorily. It had three outstanding defects :—

(i) It fostered undesirable competition between British firms.

(ii) It depended entirely on the volume of traffic obtained, and was based on a far too optimistic estimate of this traffic.

(iii) It was too complicated in its application.

The first defect—that of the fostering of competition—at first sight appears to be an advantage; all our British trade has been built up on competitive lines and " healthy competition " has always been considered the only sure preventive to inefficiency, slackness and dishonesty. Air transport, however, is an exception. On the Paris route there were already two heavily subsidised French air services in operation, and these, with the three British companies, afforded facilities to the public much in excess of demand. The sytem of payment also followed the good old Biblical precept that " unto him that hath shall be given, and to him that hath not shall be taken away." This was also rather a deterrent. The result was that money and energy were wasted by each company in endeavours to knock their rivals out of business, and in competing for a volume of traffic which was only large enough to provide one company with an appreciable load. This, of course, was the last thing in the world that was intended. The subsidy was given with the first object of putting British aircraft and British pilots into the air, and of extending British influence and prestige in this new industry which is eventually going to revolutionise the transport of the world.

High hopes had been entertained of a large increase of traffic over previous years during 1922, but actually the number of passengers had scarcely increased at all. As against the 10,800 passengers carried in 1921, 12,400 were carried in 1922.

Simultaneously the hire-purchase system for providing equipment for operating companies was proving to be impracticable. When the scheme was devised, it was no doubt intended that, if an operating company required, let us say, four machines for a certain service, two

complete machines with engines would be provided by Government. Actually the companies had selected the items they required most, and the expression "half the fleet" had been interpreted to mean half the capital expenditure, with the result that in one case a company took nothing but engines and provided its own aircraft, and, in another, only aircraft had been provided by Government. This led to considerable confusion. A still more serious difficulty was the fact that all this equipment was more or less experimental, and was constantly developing minor defects of every description. It was suffering from what might be called teething troubles, and the poor Government found itself standing between the manufacturer on one side and the operator on the other, both of whom naturally tried to saddle the Air Ministry with the responsibility of the failures which had occurred. The situation became impossible. Such a system might have been workable with organisations employing standard motor cars or railway engines, but with experimental aircraft it was quite impracticable.

By the beginning of May it was obvious that the scheme was not working well. All three operating companies were losing heavily, and could see no hopes of any tangible improvement in the future. About the end of May it was decided by the Air Council that something must be done at once. A scheme of compensation for past losses was first arranged. These losses were the direct result of deficiency in the passenger and goods traffic; so the amount of compensation was calculated on the number of passengers anticipated when the subsidy was drawn up. The increase hoped for was reckoned at 65 per cent. on the traffic of 1921, of which it had been contemplated that 75 per cent. would have been carried by British aircraft.

On this basis, for each passenger less than this number, a grant of £10 17*s.* 6*d.* was allowed as representing the amount that could have been received in fare and Government subsidy. This gave us the lump sum which should have been expended on firms if traffic had come up to expectations. This lump sum was divided into two—one-half was divided between the firms in proportion to the number of passengers they had actually carried, and the other half in proportion to the seats they had had available. This sounds rather complicated, but I think it was just and that it met the situation. This system of payment was made to apply up to September 30th, during which time a new scheme had to be drawn up and approved by the Treasury.

Even this new scheme was, perforce, of a temporary nature, as the money available would only last for about another 18 months. At the end of that period, that is somewhere about the beginning of 1924, most of the £600,000 allocated for the subsidies would have been expended; so the new scheme was only intended to remain in force for the period during which some more far-reaching line of Government policy regarding air transport must be evolved. This temporary scheme was based on the following desiderata :—

(i) to preserve the three existing air transport companies, but to prevent them competing amongst themselves;

(ii) to extend British transport activities as far into Europe as possible with the money available, and to establish at least one internal air route in Great Britain.

The first requisite of a satisfactory air route is traffic, and a map of Europe shows that the three nearest points which can provide any serious bulk of traffic are Paris to the south, Cologne to the east and Berlin to the north. The Paris route had been operated for practically

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three years and had an established goodwill, and although it does not offer a great saving of time over the train, a comparatively heavy traffic can be counted on during the summer and at least 10,000 air passengers and 300 tons of excess baggage, parcels and newspapers, can be depended upon to cross the Channel to and from Paris during the year. On the central route as far as Brussels, the small volume of traffic and the small amount of time saved over the train and boat service prevent the success of an air route in the immediate future; but by flying a 100 miles further to Cologne a great deal of time is saved; Customs troubles on the German frontier are avoided; the train traffic from Frankfurt and Berlin is tapped; and a profitable client is obtained in the Rhine Army.

On the northern route Amsterdam is of little value as a terminus because train and boat connections are too good and traffic demands too small, but Berlin *viâ* Amsterdam at once offers a great saving of time and discomfort, and should provide a comparatively heavy traffic.

In addition to aiming at reaching these three points an extension to Manchester was organised. It was hoped that this service would bring traffic to the cross-Channel services, and this hope has been justified. Even in its early stages and in very bad weather the Manchester to Amsterdam route has paid its way with the assistance of the subsidy given. Summer weather and the extension to Berlin should ensure its prosperity.

Previous to this new scheme, we had already arranged for a new route by flying boat from Southampton to Cherbourg and the Channel Islands, which will meet the ships from New York and also tap the fruit and vegetable trades of the Islands. This route will have the advantage of obtaining valuable data regarding the operation of marine craft. Personally, I hope we shall extend the Paris service beyond, either to Italy or Switzerland, and make it a more useful one than it is at present. We have not been able to reach Berlin, but I hope we shall be able to do so very soon. It is a matter of international agreement which we have not yet been able to arrive at.

Having decided on this policy it was necessary to make the money available cover the financial assistance required for these routes if possible.

After considerable discussion, arbitrary figures were laid down as representing sums just sufficient to cover the probable losses in one year on these four routes—£15,000 for Paris, £25,000 for Cologne, £55,000 for Manchester and Berlin, and £10,000 for Cherbourg and the Channel Islands. No more money was available of the unexpended portion of the £600,000 allowed for the current year.

It was also necessary to make some new arrangements regarding the supply of equipment; so the aircraft and engines which we allowed to the companies on the hire-purchase system were given to them outright up to a certain limit in capital value, each company receiving, approximately, £30,000 worth of equipment. This cleared away all our troubles regarding responsibility for failures in material, and placed the operating firms in direct communication with the manufacturers and designers. An offer was also made to furnish capital up to 30 per cent. of the value of any new equipment required by operating companies during the next financial year. I would like to add here that throughout these negotiations the Treasury were extraordinarily sympathetic, helpful and quick in arriving at a decision

on general principles, and by their assistance enabled us to bring the new system into force on October 1st.

This scheme entailed certain difficulties in that it contemplated flying into Germany, but as I have tried to indicate before, it is impossible to conceive any useful activities for three private companies working from London unless we do fly into Germany. These difficulties can be put into two classes :—

(i) those involved by flying from Holland to Berlin over the ordinary German frontier ;

(ii) those involved in flying over the occupied area to Cologne.

The regulations governing flying in the occupied area are different from those for the rest of Germany.

In order to be able to fly to Berlin *viâ* Holland it is necessary to draw up a mutual agreement with Germany.

As Germany is not yet a signatory of the I.C.A.N., by Article 5, as it stands, we cannot make an agreement with her, but, as I have explained above, the International Commission has already decided to modify Article 5, so as to permit agreements with non-signatory states. As soon as ratification of this modification is concluded, we shall have power to make an agreement with Germany permitting us to fly to Berlin and German aircraft to fly to London. The case of Cologne is more difficult. The Treaty of Versailles and the ordinances and decisions which have been drawn up since its signature forbid German aircraft to work over the occupied area until Germany has joined the International Convention. Germany was invited by the Allied Council of Ambassadors to join the International Convention during the latter part of December. Germany accepted this invitation on conditions that Articles 5 and 34 should be modified in certain respects. As I have already indicated, the modification of Article 5 is an accomplished fact and merely requires ratification, and Article 34 is up for discussion at the next meeting of the Commission. So I think we can say that Germany is certain to become a member of the I.C.A.N. during the next few months if the Ruhr troubles do not dislocate all international arrangements. Meanwhile, although by the terms of the Treaty of Versailles, Germany had the right to stop us flying to Cologne after January 1st of this year, she has permitted us to continue, whilst negotiations are in progress.

I must mention one other difficulty which lies in our path. Germany, Austria, Hungary and Bulgaria have all accepted certain restrictions on their aeronautical design and organisation under the Treaty of Versailles. These restrictions are known as the "Nine Rules." Amongst other items, these Nine Rules impose certain limitations in speed, climb and useful load, which make it impossible for these countries to employ really efficient commercial aircraft, although, of course, they are only intended to prevent the construction of military aircraft.

Germany claims that if these rules are enforced on her, she equally can enforce them against foreign aircraft crossing her frontier. If these Nine Rules are enforced, if Germany's threat holds good, and if her old allies (Austro-Hungary and Bulgaria) follow her lead, air transport to the East will be very seriously handicapped, as the only route open to our aircraft which does not impose the Nine Rules will then be *viâ* Italy and Greece.

I believe, however, that the Germans are putting forward some suggested modifications to these rules, which it may be hoped will

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remove this direct handicap on international air transport. So much for our international difficulties.

Apart from them, and assuming we get over them, this new system of subsidy now stands to be shot at; criticisms are already being made now at the reduced number of services on the Paris route, but the scheme, as it stands, promises well as a temporary measure. Actually the result is that under the old system of subsidy the Government was paying in 1921 £14 for each cross-Channel passenger. In 1922, that amount had been reduced to about £11, and under this new scheme I do not see why it should not be done for about £2 per passenger on the Paris route; so that there is some progress there.

From October 1921 to October 1922, 621,725 miles were flown.

From October 1st, 1922, to October 1923, 637,846 miles is the minimum demanded for considerably less money, and probably considerably more will be flown. 1,350 miles of air routes are to be covered instead of 420 miles, and this may be raised to 1,500–1,600, without any increase of expenditure, but that is all I can say for it; but a good deal depends on our negotiations with Germany, which are now rather uncertain of completion.

(ii) *Unsubsidised Undertakings.*

So much for the subsidised companies. There are two other organisations which deserve special mention—the De Havilland taxi-service and the Savage Sky-writing Company. Neither are helped in any way by Government, and both have done a lot of work and made both ends meet financially.

The De Havilland Service have flown the length and breadth of Europe without a single accident to pilot or passenger. During 1922, they have flown 126,000 miles in 1,400 hours. 37 per cent. of this had been newspaper and cinema work, carrying newspaper reporters to important events, 33 per cent. taxi-work, 18 per cent. aerial photography and 12 per cent. teaching. The charge made for a 250 h.p. machine carrying three passengers is 2*s*. 6*d*. per mile, and this, I believe, is to be reduced to 2*s*., which, I think you will agree, proves that air transport is already beginning to compare quite favourably with road transport. These taxi-services, of course, only start with a full load—or, rather, with payment for a full load.

The Savage Sky-writing Company has been working in various parts of England and France, and has now sent an expedition to America. It is equipped with the old Fighting Scout S.E.5. At first, personally, I looked upon sky-writing as a rather meretricious use for aviation, but actually this particular activity has produced an organisation which could be quickly converted into a fighting squadron in case of national emergency. The nature of the work demands very fine piloting at high altitudes and should provide excellent training for fighting in the air. The Company now have 12 S.E.5.a's in commission, and besides employing 16 pilots, they are giving casual employment to others. I think I can say that both these companies are national assets, and their management deserves great credit for the good work they have done.

Various small joy-riding organisations are still in existence, notably the Surrey Flying Services and the Berkshire Aviation Company. The flying hours accomplished by these enterprises are considerably less than they were in the years immediately after the War, 22,000 as compared with 36,000 and 37,000 in 1920 and 1921. I think that this is due rather to the amount of money that was lost in those early

days than to any lack of interest on the part of the public. There is still money to be made in wisely selected localities at the right time of the year. This branch of civil aviation is very valuable as a means of propaganda to the public, and also provides a certain number of training machines and good training pilots and mechanics, who would be available in case of mobilisation.

Owing to the general slump in the manufacturing industry it has been extremely difficult to keep air racing on its feet. His Majesty the King, however, has given us a great incentive by presenting the King's Cup to be competed for annually; the first race for this Cup took the form of a handicap round England and Scotland, and was flown during September last. This race was an unqualified success. There were 21 starters and not one single accident, beyond a few forced landings. It had very great value as a means of propaganda to the public, and huge crowds gathered at all the big centres at which halts were made. I am glad to say that His Majesty the King is giving another Cup this year for the same purpose. I hope that we may get even more entries, as the conditions of the race will probably again be such that any type of machine should have a chance of winning. Perhaps the best sporting feat accomplished by British aircraft during 1922 was the winning of the Schneider Cup by the Supermarine Company, with one of their flying boats fitted with a Napier Lion engine. This is an international Challenge Cup for marine aircraft, and will be competed for next in England during the coming summer. It is obvious that the promotion of racing is of distinct national value; it encourages the designer to unceasing efforts towards increasing speed, a quality which is invaluable in the fighting machine. It is also very good propaganda for the purpose of making the public take an interest in aviation, and learning to realise what it can do.

I may mention here another class of enterprise for which, like those I have just been enumerating, Government can claim no credit whatever. I refer to the individual efforts and great flying feats by British pilots, British mechanics and British aircraft. We were the first nation to fly as far as Australia and South Africa; we were the first nation to fly across the Atlantic; and to-day we are certainly going to try to be the first nation to fly round the world. Already one British expedition started off on this great adventure in May 1922, but it was a case of more haste, less speed. The expedition was hastily conceived and was not too well organised, and so I am afraid did not do much good to the cause, owing to the very long time it took to reach Calcutta, beyond which it eventually came to an untimely end. To-day, however, we have no less than five different groups of pilots who are thinking out schemes for this magnificent effort. If it is not done this year, I think it ought to be done next. In any case, the Air Ministry are all out to help in every way possible (except with money), any expedition which can prove that it is soundly organised, that proper arrangements have been made in the different parts of the world over which it will be necessary to fly, and that it has a sound financial backing.

(iii) *General résumé of British progress in Europe.*

I have already described to you the developments in the operations of British air transport during 1922. They do not amount to very much, but I do claim that we have made some slight steps in

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the right direction. I must now fall back on a few statistics to indicate the progress which has been made in other directions.

Safety and reliability are the two most important objectives which air transport has to attain to-day. When we have established those two factors we shall have no more trouble in obtaining traffic. Taking safety first; during 1922 there were only three fatal accidents to British civil aircraft. One was the unfortunate death of Sir Ross Smith and his mechanic at Brooklands. This was due to an error of judgment on the part of a pilot flying a type of aircraft of which he had no experience and after a long period away from flying altogether. This accident cannot be taken as a proof that air transport is dangerous. The second was a collision which took place in very thick weather in France between a British machine and a French machine. The British machine was doing a trial flight and had no paying passengers, but its pilot and cabin boy were killed. Its wireless was not working. The real cause of this accident was that no rules of the road had been laid down for the Paris service, because everyone had optimistically assumed that the air was so big that aircraft would not run into one another. Personally, I have always looked upon collision as about the only danger in air transport in the future, just as it is the only real danger on a railway or at sea. Definite routes have been laid out now—London to Paris, London to Cologne and London to Amsterdam—and aircraft following these routes must always keep to the right of certain objects on the ground and thus avoid the chance of collision. The third accident happened to a private machine flown by a pilot with very little experience. It was due to this inexperience, and unfortunately two of his friends who were flying with him were killed. As a result of this accident the test required to obtain a "B" licence has been made considerably more severe.

Thus, there have been no fatal accidents to passengers on regular British air routes during 1922; only one passenger was slightly injured in a collision on the ground; beyond this there were six minor accidents, in none of which anyone was hurt. No paying passengers were either killed or injured on joy-rides. During the year the regular subsidised services carried about 10,100 passengers and 22,200 flew on joy-riding flights. I think we can fairly say that the results of 1922 point to air transport being a safe means of progress if properly organised and properly administered.

Reliability is more difficult to assess, but I can give you one set of figures which point to progress. During 1920, of 1,869 flights commenced by British machines on the London–Paris route, 80 per cent. were completed within four hours; during 1921, 1,926 flights were commenced, and 89 per cent. of them were completed within four hours; in 1922, 2,055 flights were commenced, and 92 per cent. of them were completed within four hours. It must be remembered that these flights covered all the worst part of the winter, and that the percentage of reliability during the summer months was very much higher. Again, I think we can claim definite progress towards the reliability which I foresee we shall obtain before very long.

Engine and installation failure is rapidly vanishing. During September, October and November, in 1,414 flights there were only four cases on the subsidised routes across the Channel. I think only one of those was actual engine failure. There were three installation failures which could have been avoided.

The next point of interest is our progress towards economical running. In 1921 the maximum number of British aircraft employed on the cross-Channel services was 13 during August; and each of these 13 machines did 12 cross-Channel flights during that month. In 1922, during the same month of August, 24 machines were being operated, but they carried out double the number of flights, each averaging 25 flights per month. This is a step in the right direction, because during 1922 we have, on the average, got twice as much work out of each aircraft as during 1921; but we can get much further than this. One machine, a D.H.34, EBBS, operated by Daimler Airways, flew on 127 days out of 165, covering a total of 80,000 miles. That aircraft is still running and completed about 108,000 miles in the nine months since April 13th, without overhaul, which works out to about 135,000 miles, or 1,500 hours a year. This aircraft has not been fully worked, and I believe we can get 2,000 hours a year from one machine with good organisation and heavy traffic—not out of each engine, but out of each aircraft.

We are also progressing in the amount of flying done by pilots. In 1921 it was generally considered that a pilot could not be expected to fly more than about 400 hours in the year. On the experience of 1922, I am inclined to think that a pilot can fly 600 hours in the year quite easily. In July last one firm's pilots averaged 62 hours' flying each, and eight pilots, who have been flying regularly during the six months June to November, averaged 48 hours a month each without any ill effect. This is another distinct step towards economy.

The increase of traffic carried on the London–Paris route, which is the only route of which we have statistics for more than one year, is disappointing. In 1920, 6,383 passengers crossed the Channel, and in 1921, 10,731. During 1921 in certain quarters, including Government circles, a profound optimism regarding the increase of traffic prevailed, and, generally speaking, the subsidies for 1922 were based on the expectation that there would be at least 20,000 passengers carried across the Channel during that year. Actually, only 12,365 crossed the Channel during 1922. The reasons for this, I think, are threefold: (i) the two unfortunate accidents I mentioned earlier took place just as the services were getting into their swing for the summer—a collison and an accident to a French machine; (ii) the weather in the earlier part of the year was exceptionally bad; and (iii) there had been a general financial depression in America and Great Britain. It must be remembered that London–Paris is a bad route on which to gauge the possibilities of air transport; it is too short to give any real advantages to the business man beyond greater comfort than the ordinary methods of train and boat; and its passenger traffic is very seasonal. I hope that, if we can get our Cologne and Berlin services running regularly, we shall find we can get a much more reliable and constant volume of traffic for these centres than we do for Paris.

The nationality of these passengers is interesting. Out of the total 12,000 odd in 1922, 6,600 were aliens and 5,500 were British, and most of the aliens were Americans. During 1921 British aircraft carried only 49 per cent. of these passengers; during 1922 we carried 76 per cent. Neither of these totals can touch the 91 per cent. which we carried in 1920 when air transport lines were endeavouring to prove to Government the value of air transport at their own expense before they had lost their money. A satisfactory feature of the traffic is the increase in the carriage of mails, newspapers, parcels and excess

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luggage. During 1922, 208·6 tons were carried across the Channel, which gives an average of 19 tons a month. During 1921, only 19·4 tons were carried during the whole year. A considerable proportion of this extra weight was newspapers, for which a regular service was run from Lympne to Ostend for some months regularly during the summer, and was of value, I believe, to the newspapers concerned. Considerably more flying on the regular routes took place in 1922 than during the previous year, the figures being 632,000 miles as opposed to 221,000 in 1921. I certainly hope that the newspaper traffic is going to help, but it must pay its way.

We have also made some progress in medical experience. It must, however, be realised that three years is a very short time in the flying life of a civil pilot, and that it will be some considerable time yet before we can say what the flying life of a pilot is. Personally, I expect it to be something in the neighbourhood of 20 years at least. All licensed pilots are very carefully supervised and examined by the special medical adviser to the Civil Aviation Directorate. Experience shows that, if a pilot is examined, either every six months, or after every 250 hours' flying, we can keep close enough touch with his health to ensure that he is properly looked after and made to rest, if necessary. So far it seems to be fairly well proven that, so long as a pilot maintains reasonable habits, takes regular exercise, and does not overdo smoking and drinking, he can do almost any amount of flying without ill effects; in fact, aviation seems to be an extremely healthy occupation. There is, of course, a certain amount of strain entailed in conducting a large machine, full of passengers, over a difficult country in bad weather, and that is why the limits of six months, or 250 hours, for the periodic medical examinations have been determined. All the data obtained during these examinations are being very carefully kept and collated to assist us in drawing up rules and regulations for pilots' licences in the future.

We have also made some progress in organisation. First, definite routes have been agreed between London and Paris, London and Brussels and London and Cologne. These routes are marked by features on the ground, such as roads, railways, canals, &c., and every aircraft using them has to fly to the right on the route laid down, unless they keep clear at a distance of 10 km. This is a first endeavour to prevent any chance of collision.

A route to Amsterdam is under consideration now and will shortly be approved.

During the spring of 1922 the wireless telephone was brought into use for the first time in air transport. At first this invention was looked upon askance by the pilots—pilots are the most conservative people in the world and they absolutely loathe anything new—and its reliability was much criticised, but the pilots have now learned its value and object to flying without it, and from the moment this change of mind took place matters improved and the reliability of the wireless apparatus has steadily increased. A definite system of wireless control has now been established for British aircraft working from Croydon. There is always a Traffic Control Officer on duty at Croydon in the control tower. He has before him a chart on which he marks the position of all the machines on the routes to Manchester, Brussels and Paris. Each British machine as it leaves Croydon has to make its number, thereby testing its wireless apparatus and indicating to all wireless stations that it has started. At certain points on the route it has to report itself to the Control Officer and beyond

this, unless special information regarding the weather is required, or in case of emergency, the pilot is not allowed to speak. The Control Officer is responsible for following the movements of all aircraft on the route. He feeds them with information regarding the presence of other aircraft in their vicinity and regarding the weather in front of them, particularly concerning the aerodromes for which they are bound. This control system has been in operation for about six months and is steadily improving. Our responsibilities extend to the French and Belgian coasts on the other side of the channel, but, as neither the French nor Belgian wireless organization is as far ahead in development as ours, we are, in fact, communicating with our aircraft beyond those points. It is proposed, in future, however, to provide control stations at Brussels and Paris on the same lines as that at Croydon, and make them responsible for handling all aircraft in their allotted zones. Further than this, if a pilot finds himself lost in very thick weather, he can call for his position. On this call, the wireless stations at Pulham in Norfolk and Croydon take his bearing; Pulham communicate their reading to Croydon; Croydon plots the position of the aircraft from these two bearings and telephones it to the pilot. If a pilot finds he is being forced to land through engine failure in the Channel, he can send out an S.O.S. signal. The present S.O.S. signal is "Mayday," which I believe, means "Help me" in French. On this signal, his position is plotted as indicated above and information is sent to Dover, where a tug is in readiness, to all our coastguard stations, and to all ships. This system has actually been tried and the tug reached the flying boat which was feigning a forced landing in the Channel within twenty-three minutes of the S.O.S. signal being given.

As traffic increases, this control system will have to be developed and it should be particularly useful for night flying. Last night we started experimental flying by night, and the wireless was working perfectly. The machine left Croydon at 6.30 or thereabout after dark on its way to Paris. When it reached the Channel it was told by wireless that there was a fog at Abbeville, and that it was impossible to reach Paris. The machine accordingly turned back and landed safely at Lympne. That is one way in which wireless is going to help night-flying. It may really be said to-day that the only form of weather which stops air transport is thick fog; unfortunately, London and Manchester are more afflicted with this curse than almost any part of the civilised globe. However, I hope that this meteorological disability will help us to produce the finest pilots in the world, and force on our progress in air navigation.

As this wireless organisation improves we shall be able to find our way through fog, and I am sure that before long we shall abandon the fixed routes marked on the ground, and fly entirely by compass and wireless navigation, certain zones in height and area being allotted for each stream of traffic.

There is also little doubt that in the future all aircraft will be provided with a navigator in addition to the pilot—and, personally, I think that this navigator will tend to become the captain of the ship and give his orders to the pilot. The best training for a navigator will be piloting, and all navigators should be pilots first.

At present, all aircraft carrying ten or more passengers must have a navigator on board, and be provided with wireless. In two years' time, an order will be brought into force demanding that every aircraft engaged on international traffic must be provided with wireless.

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Meanwhile, I think that we as a nation can claim to be ahead of anyone in traffic control organization and in wireless navigation.

(iv) *General Progress of Air Transport Outside the British Empire.*

I must now give you a few brief details regarding the progress of air transport in other parts of the world. France, of course, is leading the way. Her Government, from the moment the war ended, was inspired with the enormous possibilities of air transport, both as a military reserve and as a means of extending political influence in the countries through which it flies. With this belief before them, they have continued to spend more and more money towards the development of French air transport lines through various parts of Europe and of Africa. During 1922 they had 13 air routes in operation, as against 8 in 1921, covering a total length of 5,300 miles as against 3,430 in 1921, and were scheduled to fly about 2,226,000 miles in the year. The most successful of these is that running from Toulouse to Casablanca. It is a daily service, accomplishing the journey in 26 hours and covering a distance of 1,153 miles. This service is run very regularly and is now carrying about 190,000 letters a month. It has lately had a branch made from Casablanca to Oran and it is intended in the near future to push it on the Dakar. The next most important is the Franco-Rumaine Co., which runs from Paris through Strasburg and Prague to Warsaw in the north, and Constantinople towards the south. The Warsaw service has been running for some time, but the southern line only just reached Constantinople at the beginning of the winter. The whole of this route is closed down for two or three months during the winter. The French are anxious to start a line through Marseilles, Italy and Greece to Alexandretta, and a group of French business men and financiers are definitely considering the organisation of such a route in the hopes that we will organise a route from Alexandretta to Baghdad and on to India, so as to get a through line to India. The French lately have followed our lead in eliminating competition between French companies. Up to quite lately, two French companies were running between London and Paris, but at the request of the Government, these two companies have now been amalgamated.

The proposed French vote for civil aviation for 1923 totals 155¾ million francs; this includes the technical department, which serves the military side of aviation as well as the civil. About 47¾ million francs are devoted to direct subsidies; it is difficult to gauge the exact value of this sum in sterling, but I should put it at almost £1,000,000 when the local buying power of the franc is considered.

Germany also, in spite of her disadvantageous conditions, carried out a lot of flying during the summer of 1922. It is German policy to shut down all lines during the winter because they have so little equipment that they cannot carry out extensive air services throughout the year. During the summer of 1922 the Germans were operating 15 air routes as against 7 in 1921, covering a length of about 3,980 miles as against 1,695 in 1921, and her aircraft were scheduled to fly about 1,030,000 miles as against 615,000. The most remarkable German line is that which has been opened from Koenigsberg to Moscow, and which is being run during the winter. The company operating it is a combination between German and Russian interests. It has a monopoly of air transport in Russia and a guarantee as to profits from the Soviet Government. It now runs twice a week and by it the journey between Berlin and Moscow now only takes 22 hours, as opposed to five days

by ordinary means. The aircraft used on this route are Fokker monoplanes fitted with Rolls-Royce Eagle engines. The German Government realises the vast possibilities of air transport in the future. They have expressed themselves anxious to co-operate with us in every way, and there is no doubt that they propose to develop this German-Russian company in Russia to the utmost extent possible. Incidentally they are operating a very successful air service with seaplanes, along the River Magdalena in Colombia, South America.

In America there is a great deal of private joy-riding going on, but there is no Federal legislation and no controlling authority for civil aviation. It is therefore impossible to gauge what sort of progress is being made. There is, however, a very interesting air service being run by the Post Office. It is operating regularly every day between New York and San Francisco, the journey taking approximately 56 hours. The service has so far been run over a section by air by day, and then by night by train and then another section by air on the following day, but it is now intended to fly right through, and one section of the route between Chicago and Cheyenne is being organised for a night service, with light-houses, &c., and after that, they intend to run right through. During 1922, a total of 175,000,000 miles were flown on this route and about 49,000,000 pieces of mail were carried. Letters go by air service as a matter of course, and the public are not charged anything extra nor are they asked whether they will have their letters sent by air or not.

The Dutch are running a very efficient service between Amsterdam and London. It is supported by Government. They are using Fokker monoplanes with British Siddeley-Puma engines, and the standard of their regularity and safety in running and general efficiency is very high. I have always maintained that the Dutchman is going to make one of the best air pilots in the world, just as he was one of finest sailors in the old days, and I think this initial service bears me out. The Dutch Government have great schemes for a service running through the Dutch East Indies, in which they hope we will co-operate by linking up to India on the one side and Australia on the other. That will eventually be part of a through line to Australia.

In Belgium, a new company has been formed in which the Government will have considerable interests, for the operation of air transport in Europe. It is not clear when this company will start operations. In the Belgian Congo, seaplanes have been operating (with considerable success) following the Congo River from Leopoldville to Stanleyville—a distance of 1,077 miles.

Practically every other country in Europe is convinced of the importance of air transport and is doing its best to develop it with the funds at its disposal. The Czechs are already negotiating for an agreement with ourselves, by which a combined British and Czech company will run over a certain section in Central Europe. The Spanish are just about to bring to a conclusion the preliminary negotiations for a big rigid airship service between Seville and the Argentine. They have already for some time been running an aeroplane service between Seville and El Arish in Morocco. This service, up to date, has been equipped with British machines (de Havillands) and been manned by British pilots, and it has been remarkable for its regularity and efficiency.

That is all I have time to say regarding developments outside the British Empire. It is obvious that sound and comprehensive international agreements are necessary before European air transport can

be really efficient. It is also obvious, from the business point of view, that a service running from London to Constantinople should be equipped with standard machines and standard engines right through the length of the route. It is logical to expect that different countries traversed by such a service should do something to support it. It is, however, an unfortunate fact to-day that every country looks upon air transport as a form of military reserve, and, with that end in view, every country desires to have her own pilots, her own aircraft and her own engines, a state of affairs which is impossible from the economic point of view for the running of through lines. These difficulties will last so long as air transport needs a Government subsidy because, naturally, every Government giving a subsidy desires a *quid pro quo* in the shape of employment for her flying personnel and for her aircraft factories; but the moment air transport can stand on its own legs without Government financial assistance, then the economic factor will prevail and international differences will vanish. The country producing the best and most experienced pilots, the most dependable mechanics, and the safest, speediest and most robust aircraft and engines, will then get its chance of benefiting by the development of air transport all over Europe. I hope, and I rather believe, that if we play our cards properly we ought to be the country *par excellence* to whom every big international company will turn when they want really good men and material.

(v) *Air Transport in our Overseas Dominions.*

Our overseas Dominions all realise the great potentialities of air transport.

Australia leads the way. She has exceptionally good meteorological conditions. She has organised two long air-routes, one from Geraldton to Derby—1,200 miles—and another from Charleville to Cloncurry—580 miles.

The Geraldton–Derby service runs weekly, with Bristol Tourers, which carry only two passengers; the operating company proposes to get larger machines as soon as they can. During the first nine months of their operations they attained to 97 per cent. efficiency; during the last four, 100 per cent. No accidents have occurred and the time saved over other methods of travel is nine days. Letters are carried for a 3*d*. surchage and have averaged a little over 1,100 a trip. The annual Government subsidy to this service is £25,000. The company has issued a dividend of 10 per cent. and has laid by more profits as a reserve, so that incidentally they are making air transport pay.

Two more routes are being organised—Adelaide to Sidney, about 1,050 miles, and Sidney to Brisbane, about 500 miles, at a total cost of £29,000 more. The subsidies sound low according to European standards, but Australia has great advantages in climate, which means regularity, and these are long distances over which air transport is going to save a lot of time. Both these factors will ensure *traffic*, and a good volume of traffic at once reduces the financial assistance necessary.

I have a few statistics concerning Australia which are of interest :—

The grant for civil aviation during 1922 was £159,500, including £88,000 for direct subsidies and £56,000 on aerodromes.

There are 20 Government aerodromes, 33 Government emergency landing places, and 10 private aerodromes in Australia—and at present there are 42 licensed pilots and 78 ground engineers. They only want up-to-date aircraft to make air transport a great success

without much financial assistance. Australia is an example of the advantages to air transport of bad communications and a good climate.

In New Zealand, a subsidy has been given to three companies on the basis of payment for pilots, aircraft, aerodromes, &c. In the year ending March, 1922, 69,000 miles were flown and about 9,400 passengers carried; I expect that this was mostly joy-riding.

In Canada, private enterprise has done very little, but the Government have accomplished a great deal of most useful forest survey and fire patrol work, whereby a vast amount of time and a great deal of money has been saved.

In South Africa and India practically nothing has been done because there has been no money to spend. A very little money should be able to put air transport on its wings in these two countries, where climate and great distances are both very much in its favour.

In Newfoundland efforts have been made towards survey and reconnaissance for seals, but not much has been accomplished so far. There is a scheme afoot now for a service up to Labrador, which would save weeks of time and should prove a great success if gold is really found in Labrador in any quantities.

Here I must just mention the Cairo–Baghdad service, which is being run, as you know, by the Royal Air Force. During 1922 it completed one year's operations. It flew a fortnightly service between Cairo and Baghdad, scheduled for two days, but actually during bad weather taking three or four days. No serious accidents have taken place during these operations.

The underlying reason of this service is to train Royal Air Force pilots in long-distance flying and independent operations in the desert, but the opportunity is taken to carry mails and official passengers on their trips, so that the training can fulfil a useful secondary purpose.

The number of letters carried has steadily increased from a little over 10,000 during the first quarter to 50,000 in the last quarter. This does not sound much, but it must be remembered that the total bulk of mail is very small and that actually 28 per cent. of the inward mail and 19 per cent. of the outward mail has been carried by air. This is a very high proportion for the first year, and it must also be remembered that, although this service runs regularly and saves a great deal of time, it only runs fortnightly, which is apt to cause considerable confusion in business correspondence which also makes use of the weekly mail carried by sea. The reliability of the running has definitely improved. During the first quarter an average of 14 days was saved on each trip over the ordinary methods of communications; during the fourth quarter this average saving was increased to 18 days and at one time it has risen as high as 19 days.

The chief difficulty of this route is that there is a tract of 550 miles desert between Amman, our first station in Trans-Jordania, and Baghdad, and for practically 500 miles there is no possibility of filling up with petrol. As there is a very strong west wind during the greater part of the year, it is necessary to carry as much as eight hours' petrol when flying from Baghdad to Amman in order to make sure of getting through; otherwise flying conditions are exceedingly easy, and the weather generally, except just over the hills near Jerusalem, is very good. Heavy rains occur occasionally, which make some of the aerodromes impossible for getting off and this has been the chief cause of the small delays which have occurred in the schedule time table. In fact, this route is a perfectly simple air transport proposition except that the available paying load is very small and that under

present conditions it is necessary to fly 500 miles without stopping; this reduces the useful paying carrying capacity to a very small amount and makes the service an impossible commercial problem without heavy financial assistance. A shorter stage might be obtained by organising a refilling point in the middle of the desert where water can be found. The transport of petrol to this refilling point would, however, be an expensive item.

If this service could be continued to India it is certain that a very much greater volume of traffic would be obtained, and the physical disadvantages of this link in the service would be to some extent counterbalanced by large takings.

(vi) *Airships.*

Now a few words about airships. I cannot say much because there have been absolutely no developments since last year, but Commander Burney is going to speak after me and give you his ideas regarding the possibility of organising an airship service to the East on a commercial basis.

The Government offer of May 1921 lapsed some time ago, but the material has been preserved in case the Burney scheme came into operation. The airships which still exist are R. 36—a service airship converted for commercial work. She is fitted with comfortable cabins and carries 50 passengers, with a fuel endurance of about 50 hours, R.33, built for war purposes, and a sister ship to R. 34, which flew across the Atlantic. R. 80 a small ship which would be useful for training purposes—the American crew of the ill-fated R. 38 was trained in her. L. 71, a 1918 Zeppelin with great speed and climb, but probably too lightly constructed for commercial work. R. 37, a sister ship to R. 36, which is about 90 per cent. completed.

These ships are all stored at Cardington and Pulham. In addition, there is a considerable quantity of airship stores of all descriptions, including engines, at these two stations.

The only tangible offer before the Government at the present time is that of Commander Burney, who wishes to form a company with a capital of £4,500,000 with a view to organising a bi-weekly service to India with a weekly extension to Australia. This scheme involves the construction of nine airships of the very latest German design. New sheds would be required at home, in India, and in Australia for the overhaul of these ships, whilst mooring masts would have to be provided in England, Egypt, India, Rangoon, Singapore, and Australia.

The Burney scheme is still under consideration, and I am not at liberty to give you any further information regarding its exact position to-day. Its adoption would commit the Government to financial assistance in the shape of guaranteed interest up to limit of £225,000 a year tax free for 10 years, and would also involve Government in a liability for this large capital in case of failure. As I have indicated already, the Civil Aviation Advisory Board have been considering very carefully the proposal to start an aeroplane service to India.

An aeroplane service involves crossing over and landing in European countries and two very unstable Asiatic countries—Turkey and Persia, and in the latter two particularly the ground organisation will be difficult. For this reason, quite apart from the work involved in its technical organisation, it will be a difficult route to institute from the international point of view, and I reckon that the preliminary negotiations with the countries concerned would occupy at least

a year before active work may be commenced along the whole route. We do not want aeroplanes and airships to be rivals; they are complementary to each other.

On the other hand, the airship scheme has the very great advantage that no international negotiations would be necessary. By the International Convention, airships can fly over all the countries on the route, and no landing organisation need be created, except in Egypt, where arrangements could easily be made. Airships also would provide a greater measure of comfort to passengers—but could not deal with intermediate traffic or provide a daily service as could be done by aeroplanes. The fact is, we should have them both, if we could afford to start them.

Foreign Powers generally are doing more than we are with airships, but mostly from the military point of view. America has a large Zeppelin under construction at Lake Hurst and another being built by the Zeppelin Company at Friedrichshaven; both these ships are about $2\frac{1}{2}$ million cubic feet capacity, and are, I believe, intended for a transatlantic service and are of the very latest type.

France has two Zeppelins taken over trom the Germans but, owing to lack of money, is making practically no use of them. She is, however, constructing some very large sheds just outside Paris, and near Marseilles. The Paris sheds are two in number and are 984 feet long, big enough to house a five million cubic foot ship. Germany is not allowed to build any ship above 10,000 cubic metres under the Treaty of Versailles. She is, however, keeping her technical staff employed on the ship which is being built for America, and has been endeavouring to get orders in Spain, Portugal, and elsewhere. Spain, as I have already indicated, is seriously contemplating a combined Spanish–Argentine service running from Seville to Buenos Aires. Italy is doing practically nothing. Beyond this there are no airship activities.

SUGGESTIONS MADE AT THE LAST AIR CONFERENCE.

It is now necessary for me to turn to the proceedings of the second Air Conference, held on the 7th and 8th February 1922, and to make some answer to the criticisms made by the speakers on the second day. Colonel Armstrong, President of the Federation of British Industries, indicated that his general opinion was that Government attached too great importance to military aviation as compared with civil aviation. I think I can only say in reply that this came about because there was not sufficient money for both. There is a certain minimum standing strength for the Royal Air Force necessary for the safety of the British Empire, and no amount of air transport will replace any portion of this minimum force; in fact it is better to consider air transport as a means of communication rather than as an organisation of military value, which after all we hope will be a matter of secondary importance.

Colonel Armstrong further suggested that services should be started between the more important cities of the kingdom. As a first effort we have started a service from Manchester, with very promising results in spite of the extremely bad weather that has prevailed since its inception.

Colonel Armstrong also criticises the policy of the Post Office. I hope that the representative of the General Post Office will reply to these criticisms in due course. The fact is to-day that none of our

air transport routes, except that from Cairo to Baghdad, are sufficiently long to give real tangible advantages to an air mail, and therefore the air mail is not patronised by the public to an extent which helps air transport in any way at all. It has been urged that the whole of the mail should be carried by air without extra charge to the public, but the trouble of this proposal is that although first-class mail matter with letters limited to a quarter ounce could be carried by air at a profit with the ordinary rates of postage if a full load was guaranteed, newspapers and other heavy matter which at present travel for less than the letter mail could not be carried at anything like these rates. The Post Office makes up on the first-class mail matter what it loses on the papers and heavy articles, and if first-class mail matter were carried by air the profits made by the Post Office on this category would not anything like cover the losses made on the papers and parcels at present rates.

When we get to the long routes I think the public will certainly patronise the air mail, even though a surcharge be demanded. A good example of this fact is the French service running from Toulouse and Casablanca. The letters carried by that service have risen steadily in the last two years from 4,000 a month to nearly 200,000 a month. If a similar service could be organised to India, I believe that within two or three years practically all first-class mail matter would be carried by it.

At the end of his remarks Colonel Armstrong urged that such long-distance air routes should be organised, and in this I concur with him most heartily, but such routes will take time to organise and will cost money.

If it was decided to operate an air route by aeroplanes to India to-morrow negotiations with the various countries concerned would probably take a year, the organisation of the route would take another year, and after that it would take yet another year before the service was in good running order; then I think at the end of another two years it would be possible for it to begin paying its way. That is a total of five years. Similarly with airships, Commander Burney's scheme demands assistance probably for ten years.

The organisation and operation of such routes is merely a matter of money. They are practically possible to-day, and I can see no reason whatever why mails should not be carried in the first stages of such a scheme in six days from London to Delhi, and in the later stages, as night-flying organisation was built up, in about 72 hours, or by airship in four days and nights.

I now have to turn to perhaps the most tiresome critic of last year—General Brancker. He expressed the hope that the Civil Aviation Advisory Board would not merely prove to be a scarecrow put up to frighten away angry and voracious critics. Well the Board has done much good work; twelve meetings of the full Board have been held, and there have also been eleven meetings of the technical committee and four of the finance committee. Last October the Board issued a report* on an air route to the East as far as India, with certain recommendations; and another report† on the question of a suitable air port for London is at present in preparation. The change of Government has prevented the first report from being fully considered up to date. It has been referred to the various

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* Cmd. 1739; H.M. Stationery Office, 1922; 1*s*. net.
† Since published by H.M. Stationery Office; Cmd. 1816 of 1923; 3*d*. net.

Departments of State concerned—the Post Office, Colonial Office, India Office—and as soon as Government has framed a definite policy for the future it will be considered seriously and thoroughly.

His next criticism was to the effect that the War Office and Admiralty were trying to smash the Air Ministry. I am glad to say that that particular trouble is now vanished, we will hope for ever. At least I believe so, although a section of the press still shows a peevish intolerance regarding the value of aviation generally, and of the continued existence of the Air Ministry in particular. General Brancker also claimed that Government never discussed both heavier and lighter than air problems together. I think I can say that this will not be the case in future, and that it is now thoroughly realised that the two branches, heavier-than-air and lighter-than-air, are interdependent.

He complained that the military side of the Air Ministry was not on speaking terms with the civil side. I can assure you that this state of affairs has ceased absolutely, and that the relations between the departments controlling the Air Force and the Civil Aviation Directorate are most cordial. The Air Staff are anxious to assist the development in air transport in every possible way, so far as money will permit. Already arrangements are being made for capitation grants to be given to civil aviation schools for the training of reserve pilots, and it is proposed also to grant an annual bonus for properly maintained engines of types which would be of value to the Royal Air Force in case of mobilisation.

His next contention was that the civil aviation department had never had a policy. It is a curious fact that in the whole history of aviation it has nearly always been impossible to make anybody look more than a year ahead, whereas in this new form of activity it is particularly necessary to look far ahead. A definite suggested policy has now been drawn up, and Government will consider whether it is possible to bring this into operation with the financial resources available. Anyway, I devoutly trust that we shall arrive at some clear policy regarding future Government assistance to air transport in the next few months.

His next criticism was that competition between British operating companies was bad, and that with the proposed subsidy too much money was being given for very limited results. I think that both those criticisms proved true. I have already described to you the crisis which occurred in May 1922, and the steps which were taken to save a general financial disaster. To-day, with the same sum of money, we shall cover 1,350 miles, and perhaps more, of air routes instead of 420 miles under the old system, and none of the money granted to the companies is being expended on trying to cut one another's throats. Of course criticisms have been made against what is called the monopoly system, but unfortunately we have to face the fact that the granting of subsidies is basicly wrong, and until we can get air transport on to a paying basis we shall always be faced by troubles arising from direct financial assistance. The public may suffer to some extent from the reduction of services to Paris. Already one of our leading firms of newspaper agents have been unable to get British newspapers carried at a very low rate in the early morning to Paris, but the fact is that the operating companies have cut their rates too low in the past in their endeavours to beat their rivals, and in consequence, have lost money. I conceive to be one of my first duties to prevent a really efficiently run British transport company

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losing money. The present system of subsidy is an effort to ensure that desirable end, and at the same time get as much flying done by British aircraft as is possible with the funds available. It is absolutely essential that companies should not be forced to cut expenditure dangerously in this stage in the way of trying to establish safety and regularity of air transport.

One of his suggestions was that the Government should encourage the formation of a big national corporation, and take some definite share in it themselves. One of the great advantages of such a policy in the early stages would be a very large saving in overhead charges. There is no doubt that to-day one well-managed company could run the three cross-Channel services at a profit with the subsidy at present divided between three companies for those services. But it is very difficult to make all three companies pay with this sum divided amongst them, because three overhead establishments have to be maintained instead of one, and there is no interchangeability of aircraft spares, &c. between the three services.

Both General Brancker and Mr. Handley Page stated that they considered it would be far better for new services such as that from Cairo to Baghdad to be run by commercial companies. I think everyone is now agreed that it would be better to run such a service on commercial lines, if it were commercially possible. A properly run commercial company is bound to be more economical from the taxpayers' point of view, but before agreeing to such a policy Government must be certain that the company is really efficient, and that it will be quite prepared to work for the big future and not for immediate profits. As I have already indicated, it could not be made a commercial proposition to-day without heavy financial assistance.

The service as it stands could not be considered truly commercial without a through connection to India, and this route has since been dealt with by the Civil Aviation Advisory Board, and is awaiting Government consideration.

Sir Samuel Instone complained that the Civil Aviation Advisory Board had no representatives from the operating companies. The representatives of the operating companies were called to give evidence before the Board. Their evidence all differed considerably, so that it is obvious that the presence of one of them on the Board would probably have led to misleading results, and if all three had been represented it is doubtful whether any useful results could have been achieved. He also criticised the small amount spent on civil aviation as compared with military aviation. I have already pointed out that this country must have a certain minimum standing air force, and until that has been made available it is very difficult to find money for air transport in the measure that its importance deserves, but we must spend money to ensure our safety at the moment before we spend it on our air power in the future.

Mr. Luke, of the Federation of British Industries, very wisely urged the extension of our air lines beyond Paris and Brussels. Our present plans reach Berlin and Cologne and I hope that this year may see us reach Switzerland without any increase of financial assistance. The longer the route, the more traffic it should attract.

Mr. Ashbolt, Agent-General for Tasmania, urged that some action should be taken to preserve airships, and suggested that we should take German airships as payment of some part of our reparations. The Burney scheme is still under consideration by the Cabinet. The question of demanding airships from Germany has also been considered,

but it is obviously undesirable that we should give German airship builders work whilst our own are idle, even though we did save money thereby.

Colonel Barrett-Lennard, criticised the Government for putting three British companies to compete for a small volume of traffic on the Paris route. His company now has the monopoly of the subsidy to Paris, and it is up to him to justify the new policy by the results the Handley Page Company show us this year. He also criticised the fact that Government threw all the risk of loss on to the operating companies. We have endeavoured to meet the quite justifiable criticism so far as is possible without allowing an inefficient company to make money.

Mr. Theodore Instone made the same criticism and in addition pointed out that with the traffic available, the £200,000 could not be spent under the conditions of the new subsidy for 1922. He was right, and matters have now been so adjusted that we know what we are going to spend.

Commander Bird pleaded that marine aircraft should not be forgotten. A sum of money has now been set aside to assist a flying boat service from Southampton to Cherbourg and the Channel Islands.

So taking it all round, gentlemen, we have not been so backward in meeting your very frank and useful criticisms—I even hope that in the future we may more than meet them all. Anyway I trust that your criticisms this year will be equally frank and comprehensive, and I could wish myself down there again this year, for there is much in the present situation that I could pick to pieces badly.

Now before leaving the subject of criticism, I must deal quickly with a statement which appeared in the press lately to the effect that air transport pilots would be useless for military purposes.

This contention is not only ridiculous, but an insult to some of the finest pilots in the world—surely the years of 1914–18 have taught us that there is no mystery in the art of war, and that our standing forces can only be the framework of our national strength. To-day I will venture to say that the few pilots which our small air transport organisation maintains would make the best long reconnaissance and bombing pilots in the world. They fly day in and day out and they have to fly to time regardless of weather.

THE CIVIL AVIATION ADVISORY BOARD.

I have already described to you the organisation of the Civil Aviation Advisory Board. I will now just mention some salient points which have become clear in my mind as a result of their investigations.

First regarding the Indian route. Three facts seem to me to have been established; that at least a daily service must be operated; that comparatively small aircraft should be used; and that night flying should be introduced as soon as possible.

Unless at least one daily through service is flown, the overhead charges are overwhelming and cannot be justified; in addition, the minimum personnel which will be required along the route will not be getting nearly enough work. It is also obvious that the benefits accruing from the daily service to India taking six days are infinitely greater than those from a weekly service. With a daily service it would always be possible to obtain the answer to a letter within a fortnight, whereas, with a weekly service, although the letter would still only take six days *en route*, it would often be three weeks before an answer could

be obtained; and the satisfaction of being able to post a letter on any day of the week with the knowledge that it would start the next morning would be enormous. Once the route was established with a daily through service flying, I have little doubt that local services would spring up on the more inhabited portions of the route. It is the possibility of running a daily service that gives the heavier-than-air route to India a very distinct advantage over the lighter-than-air. A daily service for airships would entail a very large capital expenditure, and it would be difficult to find a sufficient load to justify it.

By comparatively small aircraft, I mean single-engine aircraft capable of carrying somewhere about 2,000 lbs. It is impossible to count on greater daily demand than 2,000 lbs. in the earlier stages of the service and, where local services are found to be profitable, it would always be easy to add another small unit; in fact, at some parts of the route there would be three or four services a day. The only drawback of the small machine is that it involves the employment of a greater number of pilots; otherwise, it is more economical under practically every heading, particularly as regards handling and housing.

The necessity of introducing night flying as soon as possible is, of course, obvious. In my calculation of six days from London to Delhi, I allow for flying at 100 miles per hour for the daylight hours only. When night flying is possible this period of six days will be at once reduced to about 72 hours. It would be impossible, of course for passengers to travel right through in an aeroplane at this speed, but there is nothing to prevent mails and parcels from doing so, the passengers being dropped for the night and catching another aeroplane the next day.

As I told you just now, we are starting to experiment in night flying. We are going to run a service to Paris and back throughout February. That is not for the purpose of finding out whether night flying is possible; we proved that during the war. We are trying to gain experience as to just what it is we want in the way of wireless, reporting of weather conditions and lighting on the ground. The expense of night flying is on the ground installation. I strongly suspect that we have been spending too much money upon it, and that we can cut it down a good deal.

I must now turn to the second report of the Civil Aviation Advisory Board. The result of their investigations into the problem of finding a suitable air port for London. Various sites and possibilities have been considered. I think it was I, myself, who suggested last year that the question of building an aerodrome on the top of one of our great London railway termini should be looked into. This has been done and it is quite possible to build such an aerodrome; but the cost would be enormous—it has been worked out roughly, and it would probably be at least £4,000,000. The desire of the Treasury to-day is to try to make any facilities provided by Government pay their way. If we built an aerodrome costing £4,000,000 and charged landing fees to cover interest on this capital, those landing fees would be high; but, joking apart, I do not think that anyone could justify the expenditure of £4,000,000 on constructing an overhead aerodrome in the middle of London. London itself suffers from very bad visibility, and the best quarter just outside London in this respect is undoubtedly that at Croydon, where the present air port is located. Croydon is inconveniently far out, and it takes at least 45 minutes to reach it in a car in ordinary traffic. The disadvantages of this are twofold. First, it takes away from the value of short air journeys, such as that to Paris,

of which an hour and a quarter is expended in a motor car whilst it only takes $2\frac{1}{4}$ hours in the air; and, secondly, the aerodrome is too far out to attract the attention of the general public and educate them up to the value and possibilities of air transport. Regarding the time factor, personally, I feel very strongly that air transport is the proper means of travelling over long distances and not for short ones and, if you are going to travel a long distance, a quarter of an hour's difference in the length of the drive down to the aerodrome really does not matter. So, when all considerations—expense, bad visibility, danger, &c.—are taken into consideration, I think there is no doubt that Croydon is the best and will be the best aerodrome in London, and that we ought to devote our energies to improving our communications with Croydon. Actually, the new switch road to the west of the town of Croydon, when it comes into operation, will reduce the time of driving from Trafalgar Square to the aerodrome from 45 to 30 minutes. I hope also we may be able to arrange railway facilities later on.

A point to remember about an air port is that it pays to have it large. A small aerodrome costs as much to keep up and operate as a big one, but an aerodrome which is only just large enough for modern machines to land and take off will probably only carry half the traffic or even a third of what a really big aerodrome will take. Thus when traffic becomes heavy, it is better from the financial point of view to enlarge your landing space, within certain limits, than to start a new aerodrome.

London will undoubtedly require at least one more aerodrome, and we may be able to turn Hyde Park into an aerodrome. It has been suggested, but I think it will take ten years to break down our conservative public opinion; then we shall be able to use Hyde Park.

RELATION BETWEEN CIVIL AND MILITARY AVIATION.

Now I come to a very important item—the relation between military and civil aviation. They are not rivals. This last year we have made very distinct progress towards a state of absolute co-operation. The Air Staff have agreed to a scheme of training reserve pilots at civilian flying schools, and are collaborating in another scheme, where it is hoped that a definite annual bonus will be given by the Royal Air Force for the upkeep of engines of certain approved types in civil organisations. The civilian training school system is about to come into operation. Treasury sanction has been obtained for a grant for the retraining of war pilots in order to fit them for appointment to the Reserve, and for the periodic training of Reserve pilots in the future.

As a start, four civilian schools at the works of four of our leading aircraft manufacturers are to be organised in different parts of England and Scotland, and arrangements are being made whereby war pilots can be given from 15 to 25 hours in the air to get them back to flying condition. After that those that qualify for the Reserve, and short service officers from the R.A.F. who join the Reserve, will receive periodic training—either during one period in the year or over a long week-end every quarter.

The other proposal to grant a bonus for approved engines is still in its infancy, but it offers such obvious advantages from the financial point of view that there is little doubt that it will reach fruition during this year.

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These are what I would term military subsidies as opposed to commercial subsidies; they offer a definite saving of money in military expenditure. The training at civilian schools will cost less than training at an R.A.F. school; it will give extra employment to the experimental establishments of pilots and mechanics at the manufacturers, it will help to keep manufacturers in closer touch with flying than is the case now, and will provide opportunity for civilians to learn to fly. The registration of engines in civil life will enable the Air Staff to decrease the number of engines held in reserve in stores. Another slight step in advance that we have made is to institute a system of calling for tenders for experimental air transport machines on exactly the same lines as are followed in the case of military machines. Specifications for three different types are being drawn up, and will shortly be issued to all designers.

Altogether I can claim that the military and civil sides of aviation are advancing together hand in hand, co-operating closely in every way, and I would rub in once more that no amount of air transport can relieve us of the duty of maintaining a certain minimum strength in the Royal Air Force. Air transport will form a magnificent reserve for the Royal Air Force, but it will take time to build up, and will never attain really large dimensions so long as it has to be given considerable artificial financial assistance from Government; when the measure of this assistance becomes small, however, air transport will begin to expand, and the moment it can be made to pay it will grow rapidly and eventually it must inevitably become a great factor in our air-power. Money will flow into the drawing offices, factories will flourish, and we shall have nothing more to worry about. But until then this new industry must be very carefully nursed, and if we think we need that great reserve in the future, now is the time to start to create it, and to lay down the foundations and establish our interests on the future air routes of the world.

THE FUTURE.

Now for the future! First—when will air transport pay? Here I can only look a little way ahead, because, as a Government servant, I cannot have any great degree of imagination and am somewhat handicapped.

To-day it has been proved practically that the D.H. 34 type, carrying eight passengers and baggage or 1,800 lbs. of useful load at 100 miles an hour on a service running twice a day each way between London and Paris should cost at the most 4*s.* 6*d.* a mile to run, this sum covering all administrative costs and overhead charges as well as running costs. If heavy traffic can be obtained, these costs at once drop. With eight services a day each way between London and Paris, the mileage cost for the eight-passenger machine can be reduced to about 3*s.* a mile. So that if you could get about 60 passengers a day each way, you could carry them at £4 8*s.* a head, or at £5 with a considerable profit without any subsidy. These are facts, and you cannot get away from them. If anybody wants to make his fortune in air transport, I have the figures for him at the Air Ministry.

This is purely a question of good organisation and sufficient traffic. As regards organisation, we are learning every day and we are very distinctly better than we were a year ago. The great secret of this organisation is to ensure that every unit of the air service—the aircraft, the engines, pilots and mechanics—is doing the maximum amount

of work of which it is capable. Even a small fleet of three aircraft, nine engines and ten pilots could make over 2,500 trips between London and Paris during the year. Having got this fleet properly organised, it is then a question of obtaining sufficient traffic to justify this amount of flying. If you take this figure—2,500 trips—and confine yourselves to passengers as a basis for argument, if these machines were eight-seaters, we should have to carry about 15,000 passengers in the year in order to ensure a three-quarter load on 300 days. Well ! only 12,000 all told were carried across the Channel during 1922, so actually to-day the traffic in passengers across the Channel between London and Paris is very often insufficient to give really full work to a fleet of three single-engine aeroplanes. So we come down to the bedrock fact that we must increase the traffic if we are going to make air transport a success, and in a way our greatest problem to-day is how are we going to induce the public to use air transport ? First, it is obvious that we must give them some advantages over other means of transport; the great advantage that aviation can claim is speed. We must therefore fly far enough and fast enough to give air transport a definite advantage in time over other means of progression. Having organised routes which give this advantage, it is next absolutely necessary to prove the safety and reliability of air transport. The public will not use air transport so long as they are afraid of being hurt or killed themselves or of serious delays occurring *en route*. In addition, the prices charged for travelling and despatching goods by air transport must be sufficiently low to attract traffic. Now, unfortunately, safety and reliability are not cheap, so that, whilst safety and reliability are being established in order to attract traffic, the high rates will prevent this traffic coming if the service has to pay its way. It is this fact that makes it necessary for Government to step in with financial aid. It should be realised that this financial aid is being given to enable air transport companies to charge reasonable rates and run at a loss during the period necessary to establish the safety and reliability of air transport and so attract sufficient traffic to enable low rates to be charged without Government assistance. This we are doing at present, and I have already tried to indicate to you the various lines upon which we are progressing.

Now to turn to the technical side, which has really nothing to do with traffic or with organisation. In an ordinary cross-Channel service to-day we find that three outstanding items of expenditure are the cost of maintenance of the engines, the cost of fuel, and the cost of insurance. There are others, of course, but these are some of the greatest, and I will take them as examples of how expenditure will be cut down in the future.

The air engine of to-day is absurdly fragile; it needs constant attention and a great many spare parts to keep it running reliably, and probably at the most it can run only 200 hours without overhaul, which means it may have to undergo four or five complete overhauls at very considerable expense every year. Now this is the result of the fact that every engine we are using to-day has been developed for purposes of war, and we have not yet had time nor spent the money necessary to produce a really economical and commercial engine. I am convinced that this can be done without sacrificing very much weight. An air engine runs in the most ideal conditions—no dust, no vibration, no clutches, no brakes—just easy, smooth running in an ideal cooling medium. I can see no reason why engines should not be constructed which could run without overhaul for 600 hours or for 1,000 hours, and

when these engines are produced we shall reduce our maintenance costs by about 75 per cent.

The cost of fuel is a very big item, but already we are well within reach of using heavy oil instead of petrol without any appreciable increase of weight. For a journey of four or five hours, when this is obtained, we shall at once save something like 70–80 per cent. on our fuel bills.

Insurance.—Insurance is partly affected by the volume of traffic, partly by technical considerations. I have already indicated that we must be patient regarding the traffic and Government must help during the time our custom is built up. An increase of traffic will increase the business of the insurance underwriters, who will at once lower their premiums. From the technical point of view, premiums are high to-day chiefly on account of the danger of an engine failure and consequent damage to the aircraft. They are not high for the insurance of goods, passengers, or crews, because the insurance underwriters realise that the risk there is actually very small. It is the expense of repairing aircraft against which they have to insure. With a perfectly reliable engine, which I believe must come, insurance rates will certainly drop, and I can see no reason why they should not be reduced at least 50 per cent. in the quite near future. In fact, to-day, already, in the case of one company which has been particularly free from breakages, this reduction has actually come about. Insurance companies are not afraid to cover death risks. It is insurance against these tiresome little breakages and so on that are so troublesome, and we have got over that.

These three big items in an estimate which I have here of the expenses of a company running several services, amount to £131,000 out of a total annual expenditure of £264,000. By means of the steps in progress I have just enumerated, this item of £131,000 can be reduced to £35,000, and our total of £264,000 annually expended drops at once to £168,000, a reduction of 36 per cent.

There are other technical items which will save money in maintenance, such as metal propellers, all metal construction, &c., &c. Again, there are other items of technical development which will not reduce the costs of running the service, but will increase our carrying capacity per horse power. First, metal construction is promising very well indeed, and it appears almost certain that considerable weight will be saved by all-steel construction as compared to the present wood construction. I believe there have been planes designed and approved already which show an actual saving of 20 per cent. in structural weight. I am not a scientific expert, but I believe that, if 20 per cent. is saved on the structural weight of an aeroplane, that aeroplane will at once have an increase of about 7 per cent. to its paying load for the same horse power. Secondly, it is uneconomical to use exactly the same engine and propeller to get off the ground as for flying at cruising speed. The limiting factor in the carrying capacity of any aircraft to-day is the amount of weight which can be lifted safely from the ground with the engine all out; once the machine is well up in the air, the engine is throttled back and this load is carried quite easily; in fact, a considerably greater load could be carried if it were not for the difficulty of getting off. Experiments are now in progress towards obtaining a variable pitch propeller or a two-gear engine by which a considerably increased weight could be lifted off the ground with the same horse power. Again, slotted wings and variable cambered

wings are being devised by which greater lift can be obtained when getting off and landing, which again means a greater load can be lifted from the ground for the same horse power.

Assuming that some of these experiments are successful, I see no reason why the useful load of an aeroplane of given horse power should not be increased by about 20 per cent. of what it is to-day without any increase of horse power. So once more I repeat the statement that I made originally : I believe that in a very few years we shall be carrying ten passengers, or their equivalent weight, at 100 m.p.h. for about 2*s.* a mile, which surely is a commercial proposition; that is, about 2½*d.* per passenger per mile. I think that is enough of the financial side of air transport.

Comfort is being improved. We shall have comparative silence before very long. Experiments are in progress in heating and ventilating the cabins, of which we know little at present. I hope this may tend to eliminate air sickness, the exact causes of which are still unknown. Personally I contend that the air is the most comfortable means of transport to-day for those who like it; in five years' time I think no one will be able to deny its superiority.

As soon as its reliability is established all mails will inevitably be transported by air, and the pounds of letters carried to-day will be converted into tons. These are only the possibilities of to-morrow.

I will not waste your time by wandering into the wonderful realms of the more distant future.

I will only say that heights of 30,000 feet and speeds of 300 miles an hour are possible, placing New York within 12 hours of London; that navigation through any cloud or storm will be as easy to the aircraft of the future as navigation of the sea is to the big ship of to-day—and to the sceptical I only say, " Compare the latest commercial air liner of to-day with the 50-h.p. box kite of 1912—and think."

Now, even though air transport could never become a commercial proposition, no one could deny its enormous value to the British Empire. I heard Commander Burney, who is going to read a paper after me, put the case for air transport very clearly the other night. He pointed out that the most prosperous country in the world to-day was America, because she was self-contained; almost the whole of her trade was carried on within her own frontiers. He pointed out how this was easily possible in America because of the quick communication provided by their excellent railway system between the various business centres. He drew the lesson that, in order to prosper, Great Britain must also arrange that the greater part of her trade is carried on within the Empire and that she must no longer depend on the European markets. The British Empire is just as self-contained as the U.S.A. in its ability to provide all it wants from its own territories. The reason that this had not been accomplished was to some extent the slowness of our communications with our overseas Dominions. If these communications could be quickened up—for example, a daily mail to India in 72 hours and a daily mail to Australia, taking perhaps a week, or less, could be instituted—it would at once become possible to increase the internal trade of the British Empire, and so by degrees make the Empire much more self-supporting and independent of the rest of the world with its changing conditions and fluctuating currencies. I cannot put a better case than that for the institution of air trans-

Sir Sefton Brancker.

port as a means of linking us up with our overseas Dominions, and this could be done before air transport was actually in a position to pay its way.

Here again we meet the necessity of educating the public. We are ruled by the voice of the majority, and no Government will face the responsibility of spending large sums on an enterprise like air transport unless it has the people behind it—and so we must leave no stone unturned to teach the public what aviation means to this country, and so get them to say that they must have it—cost what it may. When air transport does pay its way, as it assuredly will, the air services will grow and multiply, and we will automatically create a great national reserve of aerial resources of designers, progressing continuously towards greater efficiency—of factories prospering and well manned with skilled workmen—of mechanics, wireless operators, meteorologists and photographers making their careers in connection with aviation; and, above all, of pilots with real air experience—in fact, real airmen.

The CHAIRMAN: I will now ask Commander Burney kindly to read his paper.

THE ESTABLISHMENT OF A SELF-SUPPORTING AIRSHIP SERVICE.

Commander C. DENNIS BURNEY, C.M.G., M.P.: Mr. Chairman, My Lords and Gentlemen: The establishment of a self-supporting Airship Service necessitates the overcoming of many difficulties of a financial, political, and technical character and, perhaps, the least of these difficulties are those which are technical. Consequently, any analysis of the problem requires the investigation of all three factors. Technical questions are generally more interesting to the majority, but I feel that the cause of aviation will be better assisted in making some suggestions as to how the financial and political difficulties can be overcome; since, until a solution is found to those problems, no progress of any kind can be made on the technical side.

The benefits that would accrue from the successful establishment of an imperial airship service may be divided into three groups :—

(i) The imperial and political advantages accruing from a safe and cheap form of transport that would provide for the British Empire the equivalent of the through trunk railways of America in-so-far as mails and passengers are concerned.

(ii) The value in war-time of a fleet of airships together with their fuelling bases all over the world.

(iii) The value of a commercial company with British capita operating a service on a profit-making basis.

PROSPECTS OF COMMERCIAL SUCCESS.

I think it would be better to discuss the third group first, as unless there is a reasonable prospect of a commercial company earning profits, there is a definite bar to that great expanison which is essential for the full realisation of the first two groups.

I will first briefly describe what has been done in regard to commercial work; then I shall indicate the recent technical developments which allow of a considerably more optimistic estimate being made of the revenue-earning capacity of a commercial company.

When airships were in their early stages, even as long ago as 1910, a German airship company called "Delag" commenced passenger work, with a result that some 26,900 passengers made journeys. After the armistice (in September 1919), this same company, with a ship named the "Bodensee" (speed, 81 m.p.h.), recommenced the passenger service between Berlin, Munich, and Friedrichshaven. In three months this vessel made 103 flights, covered a distance of 50,000 kms. and carried 2,380 passengers and about 30 tons of freight. These statistics seem to indicate the suitability of an airship for passenger work, and this indication is reinforced when one remembers that there is no record of a fatal accident to any passenger carried by a commercial airship.

There are, however, several outstanding defects which have hitherto prevented the airship developing rapidly as a passenger vehicle, and they may be tabulated in the following order:—

(*a*) There was no method of anchoring or mooring the vessel for the purpose of fuelling and of embarking or disembarking passengers and freight.

(*b*) The carrying capacity was too small in relation to the capital cost of the vessel.

(*c*) The radius of action was too small for the great ocean routes.

The developments which took place both during and since the war have, in a very large measure, overcome these defects. Nevertheless, no vessel has yet been built which embodies these developments, and this has been due, almost entirely, to the financial depression.

Take, for instance, the mooring mast, as this is undoubtedly an invention of far-reaching importance. By means of this mast it is now possible for a ship to be fuelled and gassed as well as to receive her passengers and freight without being put into a shed. The conditions precedent to a flight are, therefore, radically altered, as not only are the risks inherent in the berthing of a ship eliminated, but the number of men required for the operation is greatly reduced. Before the invention of the mooring mast it was necessary that the ship should be berthed in calm weather. Naturally, it was impossible for a time-table to be adhered to and, furthermore, not only did this objection militate against a commercial development, but the number of men required was about three hundred—a type of overhead charge quite impossible from a commercial point of view. By means of the mast, however, it is possible to moor a vessel with only six men, and the condition of the weather scarcely enters into the question, as the operation can be carried out in a forty-mile-an-hour wind.

Experiments at Pulham showed that out of a total of 111 days during which the mast was occupied for experiments, flights were possible at any time, and, in fact, some fifty flights together with four night landings were made.

A further development of considerable importance became evident after overhaul and repair of the ship whilst moored to the mast. The experiments carried out included the changing of an engine, a gas

bag, and a propeller, as well as repairs to the bow structure and the mooring wire.

It is apparent, therefore, that the airship shed can now be considered as a dry-dock and need only be used every few months for large repairs or a general overhaul.

In considering the second clause—the high capital cost of the vessel on the basis of its carrying capacity—the most important factor is the figure that can be given to the percentage of disposable lift. The disposable lift is that proportion of the total displacement of the ship which can be utilised for the support of fuel, passengers, crew, &c. Such lift can be improved in two ways: firstly, by greater efficiency of design, and, secondly, by an increase of size in the vessel built.

The improvement possible on these lines is very strikingly shown by comparing L. 1, L. 33, and L. 71.

Vessel.	Built.	Percentage of disposable lift.	Speed. m.p.h.
L. 1 - - - -	1912	31·6 per cent.	48
L. 33 - - -	1916	47·0 per cent.	64
L. 71 - - -	1918	67·5 per cent.	73

The third clause—the necessity of the vessel having sufficient endurance for the great ocean routes—is to a great extent governed by the disposable lift factor. Another consideration of almost equal importance is that of engine efficiency and fuel consumption, and in this connection a great advance has recently been made as a result of experiments carried out. Briefly, these experiments have established beyond dispute that kerosene and hydrogen can be used together as an airship fuel. In consequence, the radius of action of a vessel has been increased by 33 per cent. and, furthermore, owing largely to the very high thermal efficiency obtainable with this fuel, the exhaust temperatures are so reduced that the life of an engine should be increased by 400 per cent. The thermal efficiency is really remarkable, as some of the tests have given a figure as high as 38·7 per cent. which, I believe, is the highest efficiency ever obtained so far, the figure for the Diesel engine being, I think, 33 per cent. As regards costs, the reduction takes place in two ways: the fuel is under half the cost of petrol and the amount required is one-third less.

I think the best way to show that these various improvements render a vessel efficient for the great ocean routes will be to give the capabilities of the new 5,000,000 cubic feet vessels which it is proposed to build. Such vessel would be approximately 760 feet in length and 110 feet in diameter at its maximum girth. Allowing a disposable lift of only 50 per cent., so as to make adequate provision for the increased ruggedness of construction desirable for commercial work, and assuming a flight of 3,000 miles as the average length of a commercial flight without refuelling, it would, allowing for contrary winds, give 44·5 tons for the carriage of mails, passengers, &c., at a speed of 80 m.p.h. If 375 lbs. is allowed for each passenger, the capacity of the ship will be 207 passengers and ten tons of mail and other freight.

Estimates have been carefully worked out for a fleet of airships of this type operating on the Indian and Australian routes. The total capital required would be £4,000,000, and details of estimated receipts

and expenses for a service between this country and India, twice weekly, are as follows :—

FIRST STAGE OF IMPERIAL ROUTE.

(Service twice weekly to and from India.)

Capital Expenditure.

	£	£
6 ships - - - - - - -	(175,000)	1,050,000
1 shed (Egypt) - - - - -	(150,000)	150,000
6 mooring masts - - - -	(15,000)	90,000
2 gas plants - - - - - -	(80,000)	160,000
Alterations and additions at Cardington - - - -		30,000
London offices - - - - - - - -		20,000
1 new double shed, Cardington - - - - - -		250,000
2 mooring masts, Pulham - - - - - -		30,000
Enlarging existing shed, Pulham - - - -		50,000
Total capital expenditure - - -		£1,830,000

Running Expenses.

		£
6 crews - - - - - - -	(£12,000)	72,000
Fuel - - - - - - - - -		115,000
Hydrogen - - - - - - - -		100,000
Bases, offices, &c. - - - - - - - -		170,000
Material for repairs per ship (£10,000), excluding labour charges, which are included in base charges -		60,000
Booking agents' fees, advertisements, &c. - - -		25,000
Insurance fund - - - -	(7½ per cent.)	78,750
Total running expenses (per annum) - -		620,750
Add standing charges—		
Depreciation (ships) - - -	(20 per cent.)	210,000
Depreciation (bases) - - - - - - -		50,000
Grand total (per annum) - - - -		£880,750

Receipts.

(Mails, parcels, and passengers for Australia are assumed to be carried).

The capacity is taken as 44 tons (16 tons of mail and 28 tons of parcels and baggage) besides 400 first-class and 400 second-class passengers per week. The load of passengers is assumed to be 50 per cent. of the capacity of parcels and baggage (at rate of 1*s*. per lb.) to be 70 per cent.; the full capacity of first-class mail is assumed to be carried, but French, Dutch and German mails, and also all Chinese and Japanese traffic, are excluded.

Commander Burney.

	£	£
Passengers :		
First class (50 per cent. of 400 each week at fare of £70) - - - - - -	728,000	
Second class (50 per cent. of 400 each week at fare of £45) - - - -	468,000	
		1,196,000
Mail (first class) : 20 tons each week at 4*s.* 3*d.* per lb., equivalent to a surcharge of 2½*d.* per ounce - -		515,000
Parcels and baggage : 70 per cent. of 28 tons each week at 1*s.* per lb. - - - - - - -		116,480
Total receipts (per annum) - - - -		£1,827,480

That is to say, there is a margin of about £1,000,000, and if the receipts were only one-half of those estimated there would still be a profit. I think, therefore, there is some justification for believing that an airship service can be made to pay. If that be so, it means that as soon as the initial difficulties have been overcome, a company should not only be self-supporting, but, moreover, should be capable of paying good dividends.

It is on this basis that the financial and political sides of the question should be investigated. I am fully aware that the figures given will be criticised, especially the revenue anticipated from the mails, but in view of the short time I have at my disposal, I think it would be better to deal with that question during the discussion.

THE FINANCIAL PROBLEM.

With most new developments it is possible to try them on a small scale. With the commercial airship operating over great distances this is not possible at first; bases have to be provided, and, second, the ships themselves are large and costly articles. No development service of much value could be started under £4,000,000 of capital.

To raise such an amount of capital on what must be a speculative enterprise some great inducement must be given. The usual inducement is a large return on the capital invested.

Obviously no responsible person would take the doubtful step of raising money for an imperial service on the promise of large dividends, as there is not sufficient experience on which to obtain accurate figures.

If the inducement of a large return is not possible, it is necessary to devise some other method of raising the capital. If security of capital and assurance of dividends over a definite term of years can be given, the money can be raised on the cheapest terms.

Under these circumstances some interest other than the shareholder must be found to take the risk, and it is submitted that no interest will take that risk unless they obtain some *quid pro quo*.

In order to meet this case, a scheme was submitted to the Admiralty last August, and it is now under consideration.

The outline of this scheme was that a commercial company should be formed to take over from H.M. Government all existing airships and their bases and to build a fleet of the latest type of vessels. The company would construct fuelling depôts and mooring bases at—

Port Said,
Bombay,
Rangoon,
Singapore,
Perth (Australia),

and would institute as soon as possible a bi-weekly mail and passenger service to India, with a weekly extension to Australia. The whole of the organisation would be at the disposal of the Admiralty in time of war, and the vessels would be provided with protective inert gas containers to render them safe from the incendiary bullet.

The Government, in consideration of the benefits previously outlined, were asked to guarantee the debentures as to principal and interest and the ordinary shares as to dividends only for ten years at the rate of 6 per cent.

Under this scheme the Admiralty would take the risk and obtain for a possible liability, not an actual one, all the benefits that would be obtained by providing all the money required.

The advantage to the Admiralty is self-evident once it is admitted that the naval policy requires airships. Once that question is decided in the affirmative, only two courses are open :—

(i) The Admiralty to provide the whole of the money; or
(ii) To take the risk (in the form of a guarantee) and provide only a small portion.

I would rather lay the claim to governmental assistance on the imperial aspect, but I am prevented from so doing by Mr. Lloyd George's statement in the House of Commons in July last, when he remarked, " No money is to be expended by way of subsidy on a commercial airship service or upon imperial communications," and he further said that he had appointed a committee to investigate the uses of airships in war-time.

However, if the line of reasoning is agreed to up to this point, it is clear, from the point of view of practical politics, that the only way of obtaining the necessary governmental backing is to make out the case for the uses of airships in naval warfare.

Mr. Lloyd George's committee—of which the present First Lord was Chairman—has now made its report, and I do not think I shall be exceeding the bounds of discretion in giving some of the arguments I used before that committee.

I have already indicated the capacity of one of the new vessels from the commercial standpoint, but from the naval side I think it would be better to consider the possibilities of such a vessel when used entirely for reconnaissance purposes Under these conditions the whole carrying capacity can be put into extra fuel and wireless equipment. The result of this would be to increase the range of flight to 12,000 miles at 80 m.p.h., or to 24,000 miles at 40 m.p.h. In other words, a vessel could remain in the air for nearly three weeks without alighting to replenish with fuel.

To obtain a comprehensive survey of the position, however, I will briefly indicate the probable effect of an air fleet organised as a fighting unit. When used in this way it is difficult to separate the functions of the two classes of air machines, as each is the complement of the other. The aeroplane may be termed the gun or torpedo tube of the airship, and the greatest air-striking power is undoubtedly the largest airship carrying aeroplanes; the planes themselves carrying torpedoes, bombs, or poison gas.

The advantages accruing to these two classes of air machines working together would seem to be as follows : The aeroplane, although not protected with armour, can attack with a good prospect of success by virtue of its very high speed and three dimensional movement. Nevertheless, it suffers from a defect so grave that it cannot replace

any form of fighting ship, whether battleship, cruiser, or destroyer. That defect is its limited radius of action.

The airship remedies this defect by giving to the aeroplane a speed and range of action in excess of any floating vessel. The airship, on the other hand, presents a target larger than a battleship, and is, therefore an unsuitable vessel to attack by itself. The aeroplane removes this defect by increasing the gun range of the airship by the radius of action of the aeroplane it carries.

The last war showed that any vessel was jeopardised if hit by a torpedo, and it is obvious that the type of carrier can have no bearing on the result—whether aeroplane, submarine, or destroyer. The torpedo is the essential factor. The two new battleships now being built are to be protected from torpedoes by extra bulkheads, saddle tanks, internal armour and other improvements of a technical character, and it is suggested that they will be enabled thereby to withstand the attack of four or five torpedoes before destruction occurs. But does any reasonable man suppose that the answer will be other than to construct torpedoes of five times the destructive power of those now made? The battleship will then be in the same danger as it is to-day—one torpedo correctly placed will so incapacitate her as to render her an easy prey to a fresh attack.

Bearing this situation in mind, it seems essential to analyse the basic conditions of sea power, if the real effect of air power on sea communications is to be evaluated.

History has shown that the prophets who foretold the elimination of the battleship by the torpedo boat and the submarine were wholly incorrect. To-day, an agitation is taking place to concentrate entirely upon aircraft, and this is opposed by a section of opinion which claims that so long as our floating trade is carried in floating vessels, so long, therefore, must floating warships defend that trade; and, since the battleship is the embodiment of sea power, it is essential to maintain battleships.

Surely, neither of these two schools of thought can be wholly correct, as the British Navy exists to perform two main functions:—

(i) To secure the sea for the transport of British merchandise, troops, &c.; and
(ii) To deny the sea to the ships of the enemy.

It exists for no other reason. The method by which it attains its objects is either to fight or contain the enemy warships, but it does not exist for that purpose. It is very necessary to distinguish clearly between the political object and the military method by which that object is attained.

If the political object—the safe transport of our troops and merchandise—can be obtained without the intervention of a floating navy, then there is no reason for a floating navy at all. It is, therefore, a fallacy to argue that if we wish to transport merchandise on the water it necessarily follows that the military appliances to enforce that result must also travel on the water. The vital issue must be to consider whether or not existing air machines contain the possibility of development to such a degree that they may eventually be able to effect the political object.

Two of the conditions precedent to the fruition of such a development have already been discussed, namely, radius of action and power of attack. Let us consider now, reliability and costs.

The air-keeping qualities of an airship depend mainly upon speed, and if her speed is high enough she will be enabled not only to maintain any assigned position, but also to make progress in the face of a heavy gale. Statistics show that the modern Zeppelin has flown comfortably in an 80 m.p.h. gale, and as the average gale does not exceed about 50 m.p.h., it necessarily follows that the modern airship, once it is in the air, has as good air-keeping qualities as the battleship has sea-keeping qualities.

As regards cost, assuming a battleship to cost as little as £4,000,000 and an airship as much as £250,000, it follows that 16 airships can be produced as cheaply as one battleship.

It is estimated that 16 airships would carry between them as many as 32 torpedo-carrying planes and 48 fighting planes, and they would be able to attack at a range quite outside that of any existing type of warship. I think it will be readily conceded that if such a force of aircraft was to attack one battleship, it is more than probable that the battleship would succumb. The essential condition is that the planes must be brought to the point of attack.

In considering reconnaissance duties, we have the fact that during the war one of the R. class airships maintained wireless touch with the Azores from the North Sea. How then does such a vessel compare for these duties with a light cruiser?

An airship detailed for reconnaissance duties only can carry extra fuel in the place of fighting equipment; and when so equipped, would have a range of action of 20,000 miles. It would, of course, be necessary for her to carry a couple of fighting planes to defend herself from planes sent up from a single vessel. A rough estimate, neglecting repairs, interest on capital, depreciation, &c., of the comparative cost of an airship and a light cruiser in searching a 1,000 square miles of sea shows that the cost by airship is £1 5*s*. per square mile and by light cruiser £77. As regards capital cost, the same work would be done by a fleet of nine airships as by a fleet of 60 cruisers. The saving in capital cost being £51,750,000.

Since armaments must be reduced to a monetary basis, as money is the life-blood of the fighting services, it is evident that no navy can afford to neglect a cheap scouting force which may develop into a powerful fighting unit.

DEVELOPMENT OF THE ROYAL NAVY.

Showing how the Lessons of History point to the Necessity of Developing on a Commercial Basis.

If it is accepted that airships are necessary from a naval point of view, it is desirable to find out how best that development may be guided.

The British Navy has developed slowly. In the early days there was little or no difference between a trading ship and a war ship, and the average vessel could be used for either purpose. Accordingly the regular Navy or King's Navy scarcely existed; only a few were retained as a neucleus, and in times of stress, merchant ships were either hired or impressed.

An interesting illustration of the large proportion of merchant vessels used in a Fleet action is given by an analysis of the composi-

tion of the English Fleet that attacked and defeated the Spanish Armada :—

	No. of Ships.	No. of Men.
Her Majesty's ships - - - - -	34	6,289
Merchant ships under Sir Francis Drake - -	34	2,392
Ships paid by the City of London - - -	30	2,180
Merchant ships under the Lord High Admiral	18	751
Coasters under Lord High Admiral - - -	20	993
Victuallers - - - - - - - -	15	810
Coasters under Lord Henry Seymour - -	23	1,090
Voluntary ships - - - - - - -	23	1,044
	197	15,549

As science developed so the divergence between the fighting ships and the trading ship became more marked, with the result that the Royal Navy at the outbreak of the war in 1914 consisted of battleships, cruisers, destroyers, submarines, minesweepers, and other special craft, and not one of these classes of vessels had any similarity to a merchant vessel. Nevertheless, the Royal Navy had to call upon the mercantile marine, not only for the transport of its own supplies and that of the Army, but also for fighting purposes. The submarine campaign called for an enormous number of vessel for purely fighting purposes, and at the end of the war there were some 3,500 auxiliary vessels converted from fishing and trading purposes.

In regard to personnel, there were enrolled in the Royal Navy three men drawn from volunteers or the mercantile marine to every man that the Navy proper employed at the outbreak of war. Without this great marine reserve to draw upon it is more than doubtful if British arms would have been successful either at the time of the Armada or during the Great War.

The lesson to be drawn from our experience, extending over many centuries is clear, and may be expressed as a necessary condition precedent to the acquisition and maintenance of sea-power, namely, sea-power must be built upon the broad basis of a great mercantile marine which in war-time co-operates with a powerful and efficient navy of specialised fighting vessels.

If this be true and if, so far as can be seen, it is probable that air-power will gradually replace sea-power, there will be the intermediate stage when the mastery of the seas depends upon securing the aerial advantage. During this intermediate stage the relative efficiency of the floating aircraft carrier and the airship-aeroplane is a very pertinent consideration. It seems logical that the cheaper, faster, and larger radius of action carrier must, in the end be adopted. And, added to these advantages is the fact that the more heavily armed surface vessels, submarines and mines which can attack the floating aircraft carrier are harmless against the flying carrier. However that may be, the fact remains that this latest three dimensional vessel can attack the battleship without having first to fight its way through the protecting screen of floating vessels. The deduction that must be drawn is vital.

The battleship to-day is the prop on which the cruisers, destroyers, minesweepers, armed merchantmen, &c., depend. Sometimes the

battlefleet comes out into the open and fights, as at Trafalgar; at other times it remains securely in its harbour, as was the case during the later period of the last war. But it is there, seen or unseen, and its actual or potential striking force is available; without it the whole naval power would fall like a pack of cards.

Obviously the patrol vessels are not concerned as to the actual form of prop so long as they can depend upon it. It may be a wooden prop as was the wooden three-decker, a wood and iron prop as the early ironclad, a steel prop as the modern dreadnought, or, as with the modern airship, an alloy prop.

If the above argument is followed to its logical conclusion, science may alter not only the form and construction of the prop, but its very characteristics.

At first sight the eventual substitution of the airship-aeroplane for the battleship appears visionary, but the facts from which deductions have been drawn are basic. It is not suggested that battleships can be given up to-day, but surely the lesson to be drawn is that airships will have a growing influence on naval strategy and tactics, and the final consideration is how can the British Empire lead in airship development.

The lesson history teaches in sea-power is that a fighting navy must be broadly based upon a mercantile marine, and in the early stages of development there was little difference between the fighter and the trader. Surely it is logical that the development of the air will follow upon the same lines. To start with, the airship will be merely a reconnaissance or auxiliary vessel, but as it develops in speed, endurance, and reliability, so will the differing requirements of war and trade necessitate a corresponding divergence of type. They will always have the same fundamental requirements in the way of bases, constructional facilities, trained crews, and the like. When that stage of development has been reached the mercantile airfleet will be able to form that great auxiliary force that can be called upon to assist in war.

If this reasoning is sound, the fact emerges that airships should be developed upon a commercial basis, and when the natural growth of scientific development renders a divergence of type between the reconnaissance or auxiliary vessel and the trading vessel desirable and necessary, then that is the moment for the commencement of a State service or Navy of specialised fighting airships.

In conclusion I must apologise for having stressed the naval and war uses of airships, when I am trying to develop upon a commercial and imperial basis but, as already explained, my hands have been tied by Mr. Lloyd George's decision, and I can only hope that the new Prime Minister will give more weight to the imperial and commercial sides than his predecessor.

TUESDAY, 6th FEBRUARY.

AFTERNOON SESSION.

Sir Henry P. Maybury, K.C.M.G., C.B., in the Chair.

The Chairman: My Lords and Gentlemen: It does not require any words from me to commend this all-important national subject to such a Conference as this. We had excellent papers read to us this

Commander Burney.

morning, and we are to have equally good ones this afternoon. You will remember that the procedure is that the papers only are to be read to-day. Those that were read this morning will be discussed to-morrow morning, and those which are read this afternoon will, in like manner, be discussed to-morrow afternoon. If those who wish to take part in the discussion would kindly send up their names to the Secretary, either this afternoon or early to-morrow, it would be very convenient. I do not propose to keep you any longer, but I will call upon Air Vice-Marshal Sir Geoffrey Salmond to read his paper.

THE PROGRESS OF RESEARCH AND EXPERIMENT.

Air Vice-Marshal Sir W. Geoffrey H. Salmond, K.C.M.G., C.B., D.S.O., Air Member for Supply and Research, Air Ministry.— Mr. Chairman, My Lords and Gentlemen : It is difficult in reviewing the year's work on Research to do adequate justice to the ardent hopes of research workers. You can *never* satisfy Research, for Research knows no horizon. It never finishes its journey, but it never relaxes its efforts to attain its journey's end.

During the year, however, much has been done, and I take this opportunity of thanking our scientists, workers and pilots, who have so loyally co-operated to produce the results achieved.

Perhaps I may be forgiven if I describe to you our organisation for research as I fear it is sometimes misunderstood. In the first place, there is the Air Ministry, charged with the general direction of research. The Air Ministry is advised by the Aeronautical Research Committee, either on the initiative of the Air Ministry or on the initiative of the Aeronautical Research Committee themselves, as to the problems which require to be solved or as to the methods by which they should be solved.

A representative of the Aeronautical Research Committee works in the Air Ministry and has direct access to me on all questions.

The Aeronautical Research Committee does invaluable work in investigating all sorts of problems, and is wonderfully assisted in its work by the National Physical Laboratory, the Department of Scientific and Industrial Research, and a whole body of scientists who give their services free to the nation, as well as by the great universities and consulting engineers.

These organisations deal with the theoretical solution of air problems in the domain of pure research. But research cannot stop here; its practical application has to be considered, and this portion of the work is carried out by the Royal Aircraft Establishment at Farnborough, various experimental stations, such as the Aircraft Experimental Establishment at Martlesham and the Marine and Armament Experimental Establishment, Isle of Grain, and by various joint committees of the Navy and Army.

A third organisation also exists, and that is the Aircraft and Aero-Engine Constructors, who maintain most capable designing staffs who constantly bring forward solutions of problems which enable us to step forward.

I would be failing in my duty if I did not here acknowledge the debt this country owes to all these organisations, the joint efforts of which have undoubtedly brought our world position as regards research to what I confidently consider is a position second to none.

Now, work of great value has been carried out in regard to wing sections, with the object particularly of diminishing the length of the

run before the aeroplane leaves the ground and at the same time of reducing the landing speeds. The rate of "getting off" is an all-important matter. At the present time the majority of machines have to carry an engine which must be run at maximum power for this purpose. Once the aircraft is in the air the economic and customary flying speeds are obtainable at three-quarters throttle, or even less. A certain amount of success has, I am glad to say, been met with in producing aeroplanes which are very much more efficient in "getting off" than their predecessors; if and when we have entirely achieved our object in this particular the aeroplane would be able to leave the ground with the engine at three-quarter throttle, so that, if desired, a smaller engine could be put in to run at the same power both for "getting off" and for flying. This would result in a considerable saving of weight, economy in fuel, and a less expensive engine, all of which are invaluable from a civil point of view, and to a certain extent from a Service point of view. As regards civil aviation, it may be advisable to explore the possibility, after testing an engine at the makers' rating of, say, 500 h.p., of devising some means, such as choking the inlet, to make it not possible for the engine in ordinary running to give more than 450 h.p., with the material advantages of longer life and lower maintenance charges.

The problems of aeroplane design which we are particularly considering may be divided roughly into three categories: firstly, the single seater fighter, where the essential quality is high performance at altitude, say, above 20,000 feet. (The wing section for such a machine is an entirely different problem from that for a civil machine.) The next category—again a Service one—embraces a very large number of requirements, such, for example, as the amphibian, the boat machine, the reconnaissance machine, &c. The third category is the civil aeroplane with which can be coupled the night bomber, troop carrier and ambulance machine.

With a single-seater fighter it is necessary to run the engine all out in order to get the requisite performance, and it must therefore be fitted with some means of maintaining power at altitude. This difficult problem is much in our minds, and is dealt with later.

As regards factors of safety, or load factors, it is a comparatively easy matter to stress a machine for normal flight and to determine the factor suitable to a given load, so as to produce freedom from breakdown. On the other hand, where stunting and aerobatics are indulged in the requirements are more stringent. Research has led us to adopt a factor of safety of 4 for civil machines where straight flying only is required; but for Service machines a figure of 7 is necessary. It is obvious that the more you can reduce this factor, having due regard to freedom from the likelihood of breakdown, the better, since this spells economy. In other words, no unnecessary weight must be taken into the air. The nature of the load distribution is of vital importance, and that this is so can scarcely be too strongly emphasised. It is, perhaps, a rather difficult matter with regard to civil machines, since you may, for example, have a carrying capacity of ten passengers and only take up three or four; where are these passengers to sit if correct stability is to be secured? This matter is being investigated and it is hoped shortly to lay down an authorised procedure. One line of investigation is to employ a small steelyard weighted to represent the weight of an empty machine. By hanging small weights on the yard representing the weights of baggage and passengers (*i.e.*, the variable weight) the centre of gravity should be established.

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These quite general considerations of the strength of the aeroplane lead to the investigation of fundamentals, of which that on materials comes first; but research by itself on materials must be useless unless ease of production, and the possibility of bulk production, is ultimately ensured. These considerations need emphasis; it is on these lines that present research work is being conducted.

Materials with ostensibly miraculous properties are frequently submitted for consideration and sometimes they do possess some, at least, of the physical attributes claimed for them; but when regarding them from the production point of view they may be, and all too often are, prohibitive on account of cost, and more often than not are impossible on the bulk production basis: when considering bulk production there is one particular element which must not be lost sight of, namely, the time taken to produce.

Valuable work on steel, light alloys, and non-metallic materials has been carried out during the past year, thanks to the various panels of the Aeronautical Research Committee, the Department of Scientific and Industrial Research, the National Physical Laboratory, scientists, and the Royal Aircraft Establishment, Farnborough.

As regards fuel, very valuable research has been carried out and decided advances have been made during the year. Once it is realised that of the running cost of a machine one half may be due to fuel it is evident that research in this direction should be accelerated. For example, the present price of petrol is about 35*l.* per ton, whereas crude oil can be obtained for about 4*l.* per ton, and the same weight of either of these fuels will give approximately the same horse power. It is of great importance to civil aviation, and to the Royal Air Force, that encouragement should be given to schemes for the direct injection of fuel, both for economy and for doing away with both carburettor and magneto.

AERO ENGINES.

Although for service purposes engines giving as high as 1,000 h.p. and upwards are under development, for civil work there is little demand for an engine larger than from 400 to 450 h.p., and with this latter it is not desired, moreover, to run during level flying at a higher horse-power than about 350. Where one engine does not suffice the tendency will probably be to use three. With three engines the chance of a forced descent through engine trouble is comfortably remote.

As is well known, the full advantage of supercharged engines cannot be reaped unless a variable pitch propeller is provided. It is with such a combination that the highest altitudes of flying are obtainable It is an interesting point, however, that there is a quite separate demand for a variable pitch propeller for the purpose of civil aviation, where very high altitude flying is not customary. With the propeller of fixed pitch it is found that the tractive effort when "getting off" is not in proportion to the torque being exerted by the engine, and that for full advantage of this torque to be obtained, it is necessary in aircraft as in motor cars for a variable velocity ratio to be employed. By this means the variable pitch propeller becomes equivalent to the gear box of a car and is used in the same way, namely, to enable the vehicle when starting from rest to attain the high acceleration.

Investigations are also being carried out with a view to introducing a variable gear in aero engines, in order to attack this problem.

Experiments are being made with an inverted form of the Napier Lion engine. The great merit that the inverted engine would have,

were it to prove successful—which there is no reason to doubt—is that it would be much more easy to lead the exhaust away than in the ordinary upright form of this engine; gravity feed would be facilitated and there are other conveniences, of course, such as improved outlook ahead for the pilot.

Research work is proceeding on the connecting rod big end loading question. What may be termed the "neck of the bottle" is at present the deformation of these bearings when forces acting in more than one direction are allowed to operate; once the question of deformation of this kind has been solved the next consideration is the limiting of the factor of loading multiplied by speed. The solution of this question of deformation will give the aero engine longer life and reduces the chance of forced landings.

One of the most promising events of the past year has been the development and use at the Royal Aircraft Establishment of a single cylinder of aero engine type to run on a "Diesel cycle." It is found that with a special shape of nozzle and "solid injection" of shale oil fuel, a brake mean effective pressure of as much as 112 lb. per square inch is obtainable, and that with an engine speed of 1,000 revolutions per minute; the fuel consumption under these conditions was 0·415 lbs. per brake horse-power hour. As this fuel costs somewhere about one-ninth of that of petrol, it will be seen that this development, if it should prove to be capable of being pressed to a practical end, would have an enormously important effect on the future of civil aviation.

Work on direct fuel injection is being undertaken also by Messrs. Beardmore. They are making initial tests on a single cylinder with a view to the ultimate adoption of the system on a 6-cylinder vertical engine. The method of injection is different from that employed at Farnborough, inasmuch as in the latter, oil at from 3,000 to 4,000 lb. per square inch is admitted through a timed valve, whereas in the Beardmore system the oil is injected by a jerk pump. It may be mentioned that it is really better not to refer to these cycles as Diesel cycles; the nomenclature approved by the Institution of Mechanical Engineers is to call them compression ignition engines; the ordinary type being called electrical ignition engines, whilst the type formerly termed semi-Diesel becomes the surface ignition engine.

A step forward in full-scale experimental research has been made by the perfection of an instrument by means of which an aero-engine can be tested in flight with an accuracy equal to that of the laboratory. This consists of the Callendar Electric Air Flowmeter which, when attached to the air intake of any multi-cylinder engine, measures the weight of air used independently of a knowledge of the pressure and temperature. The instrument has been thoroughly tested on Siddeley Puma engines on the bench and in a D.H.9 machine. The bench tests showed that it gave correctly the mean air flow, which was unaffected by variation in the engine suction, and showed that the air consumption was very closely proportional to the indicated horse-power. Observations made by Dr. Moss of the Air Ministry Laboratory during flight, climbing and level, at various heights up to 14,000 ft. showed that the air consumption and indicated horse-power for this engine was proportional to the density of the air.

Efforts are being made towards the improvement of the magneto. As a result of investigations carried out at Farnborough, in association with magneto manufacturers, it is hoped to arrive at a design for a universal magneto equally suitable for all aircraft engines and all conditions of normal air operation. It seems likely that the introduc-

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tion of cobalt steel magnets will greatly affect design. A point that particularly needs looking into to meet the temperature conditions of the Middle East, is the mechanical, physical and electrical properties of moulded hard rubbers; this work is in hand. The characteristics of safety gaps at reduced pressures are under investigation with a view to the design particularly of a suitable safety gap for use with supercharged engines.

The problem of supercharging has been seriously attacked and valuable results have been achieved both in the air and on the test bench.

AEROPLANES.

One of the most difficult problems in the design of aeroplanes is the association of a low landing speed with a high air speed. Although it is true that speeds of from 55 to 60 miles per hour are not unsuitable when landing on properly prepared aerodromes, such speeds are far too high for safety during emergency landings. Both in civil aviation and service flying such emergencies do unfortunately arise, and to provide against them it is very desirable that a landing speed of 40 miles per hour or even less should be achieved.

It may be mentioned that although the factor of safety in Service machines is commonly as high as 7 compared with the much lower figure of 4 in the case of commercial aircraft, nevertheless in service aircraft allowance has to be made for inevitable military overstressing and very considerable over-driving during air flights. As regards the introduction of very high speed machines, this is not of necessity accompanied by a lowering of the factor of safety; for instance, in the case of the well-known "Bamel" the factor of safety is as high as 6.

Again a further complication arises in the design of high speed aircraft. If the machine is for purely "racing" purposes, a high factor of safety is not so necessary as it is for the service machine which has to compete with very serious stresses when fighting.

Very rapid progress, it may be mentioned, is being made in the development of the high-speed aeroplane, and I think that this year will show a great advance in this respect.

In the study of aerodynamics, attention has been focussed upon improvement in control at low speeds; stalling is at present accompanied by such deterioration of control that straight flight can only be maintained by rather abnormal skill, and involuntary spins often result. We hope to find means of providing complete control of the aeroplane in the stalled state, so that aeroplanes may be flown with confidence at their lowest speeds, and the full speed range utilised. This will greatly increase the chances of effecting forced landings without accident. The experiments may even lead to a manœuvre of "stalled landing," which, on account of the steepness of the gliding angle when stalled and the low forward speed and high retardation, may make landings possible in far more confined places than can be safely used at present. Various systems of lateral control have been and are being tried, but the greatest improvement has been obtained by the use of a very large rudder. An aeroplane has glided steadily under good control at an angle of incidence of 40 degrees, which is a very big advance. A system of varying aileron gearing, due to Mr. Hagg and the de Havilland Aircraft Co., shows promise of improving the lateral control. The subject is being attacked from both sides—increasing

the power of the controls and reducing the tendency of the aeroplane to get out of control.

The solution of this question of "stalled" flying has been greatly assisted by the efforts of the Aeronautical Research Committee, as well as by the practical flying of pilots at the Royal Aircraft Establishment, Farnborough, involving, as may be well imagined, a high degree of skill. In order to provide the fullest opportunity for attacking this problem, special machines are being constructed, as it has been found that a service type of machine, which of necessity has been built for a special purpose, is unsuitable for developing this Research.

In order to reduce the fatigue and effort of the pilot on large and long distance machines, whilst at the same time he "feels" the control, a hydraulic servo motor is being provided to operate the three controls. An experimental model has been thoroughly tested and has given good results.

The programme of full scale and wind channel tests designed to explore the correspondence of wind channel measurements with the full scale has been completed in so far as it relates to the common form of biplane design, and the investigation will be extended to cover thick winds and slotted wings. A report is being prepared upon the basis of this experimental evidence discussing the degree of accuracy obtainable by the wind channel from the point of view of prediction of full scale performance. Apparatus has been designed which it is hoped will render performance tests independent of up or down currents in the air and thereby facilitate comparison of results.

The proposal to use airscrews in close tandem form (advanced by Capt. G. T. R. Hill at the last Air Conference) is being investigated by running two airscrews in this manner on the ground. So far no vibration troubles have occurred. Experiments which have been carried out indicate that a serious loss of efficiency is to be expected if airscrews be run at higher tip speeds than the highest now in use, 850 feet per second, but below this speed no definite data have yet been achieved.

General Bagnall-Wild in his paper last year referred briefly to the position of the helicopter type of machine. There is little to add except that a large amount of work has been done and that it is hoped that the time and effort expended will shortly be repaid. The fact that no results have been obtained so far does not necessarily mean that none will be obtained.

Metal Propellers.

During the past year very considerable progress has been made in the development of the metal propeller. It may be said now that it has proved itself to be satisfactory for replacing the wood propeller hitherto in general use, and is already in production.

The main difficulty in producing such an article is not so much a question of actual design as a question of finding out how to make it. This difficulty has now been overcome and it can be safely said that a satisfactory metal propeller can be made for any type of aircraft, with an efficiency at least as high as that of the wooden one. Still further research is necessary with the aim of investigating various aerofoil shapes in order to determine the most efficient, and one moreover which is capable of convenient and rapid manufacture. Further study is also required on the methods of construction, observing that at the present moment the propeller relies to some extent on edge welding for its strength. It is necessary also to learn whether such propellers can be best made of tapered metal sheets or of a series of

laminated sheets, a problem which will be investigated during the ensuing year.

The advent of high-powered engines has made the use of the metal propeller almost imperative for both service and commercial use. The propeller required for engines of 600 to 1,000 H.P. is so large that its transportation is a very serious problem, and there is little doubt that such propellers must have detachable blades in order to simplify this problem. The design of a propeller with wooden detachable blades is a matter of very great difficulty, whereas the metal propeller is normally so made.

The variable pitch propeller follows as a natural sequence the development of the metal propeller. In all variable pitch propellers hitherto made the principal difficulty has been to secure adequate attachment for a wood blade to a metal centre. With the advent of the metal propeller this difficulty has been removed, and it is thought that a satisfactory variable pitch propeller can now be designed to give the same degree of reliability as existing fixed pitch ones. In the ensuing year a considerable amount of experimentation will be carried out on this problem, in order to meet the demands of the supercharged engines now being designed and built.

Undercarriages.

The difficulties experienced in the use of aircraft in tropical climates have shown the weakness of rubber as an aircraft material, and steps have been taken to find a substitute, or alternatively, to re-design the parts, eliminating rubber as far as practicable.

During the year a large amount of research has been carried out on Oleo undercarriages. The Oleo undercarriage was first developed with a dashpot and rubber tension shock absorber, using rubber in tension as in an ordinary aeroplane undercarriage. These undercarriages have proved a marked advance on the ordinary type of undercarriage hitherto used, but the use of rubber in tension in exposed parts of the aeroplane is undesirable owing to deterioration. Efforts have, therefore, been made to overcome this difficulty.

Four types of undercarriages have been developed :—

(i) An Oleo dashpot combined with rubber buffers, that is, with rubber in compression.

(ii) An Oleo dashpot combined with a steel spring in compression.

(iii) An Oleo dashpot combined with compressed air.

(iv) A steel spring undercarriage with a variable leverage device.

So far as experiments have gone, the Oleo with compressed rubber has proved entirely satisfactory.

The application of the Oleo principle to tail skids has been carried out on large machines and shows promise.

Metal Wheels.—This subject is being investigated with the object of eliminating rubber tyres and taking all shocks on the Oleo shock-absorbing mechanism.

Variable camber gears.

Continued efforts are being made to increase the useful weight carried by aeroplanes. In pursuance of this both research and experiment are being carried out with a number of variable camber

devices which have been submitted for consideration. These divide themselves into :—

(i) The ordinary aerofoil fitted with an adjustable flap at the trailing edge.

(ii) The ordinary aerofoil fitted with an adjustable trailing and leading edge.

(iii) True variable camber gears which vary the actual camber of the aerofoil.

(iv) Devices such as the Handley Page slot which fundamentally affect the air flow over the planes.

(v) Combinations of the Handley Page slot with the trailing edge flap.

A large programme of work on this is in hand, and some measure of success has been achieved. With regard to slots, tests and experiments are still continuing, and the position at the moment is that it has been demonstrated that this device gives an increase of lift-coefficient of considerable magnitude, but is accompanied by an increase in drag. It is believed that this drag can be much reduced, and in pursuance of this, tests and experiments will be continued during the ensuing year.

With regard to the trailing edge flap, full scale tests have been carried out at Martlesham Heath with a considerable amount of success. It has been demonstrated that the use of a trailing edge flap will reduce the landing speed of an aeroplane by approximately 12 per cent. This in itself is an advantage of considerable importance and should be of great value to transport companies.

The other types mentioned are under test or about to be put under test in the wind tunnel. Further development of these will depend on the results obtained from these tests. It is anticipated that during the ensuing year results will be obtained which will enable the useful load carried by aeroplanes to be materially increased.

Metal Construction.

Progress in the development of metal construction has been maintained and considerable sums have been expended in this direction. There is no doubt that the metal aeroplane is now quite practical, and machines have been, and are now being built of metal. Much work is still to be done, however, from the point of view of cost reduction.

It is proposed in the present year to proceed to some extent along the lines of simplification of design with a view to producing a metal aeroplane which can be made at a reasonable commercial price and in reasonable quantities. Experience has shown that not only is the metal aeroplane more durable than the wooden, but that moderately sized aeroplanes can be made lighter in metal than in wood. It is believed that this advantage of light structure can be continued in aeroplanes of larger dimensions and that the problem of producing a large aeroplane will be thereby much simplified.

GLIDERS AND GLIDING.

Inasmuch as a separate paper is being presented to the Air Conference dealing with this subject, it is not necessary for me to give much space to it. Great interest has been aroused by the recent gliding tests in Germany, France and England, and the possibilities

opened up are of considerable importance. In the first place it may afford a means of greatly reducing the expenditure of time and money in teaching flying; secondly, it may afford an exceedingly useful method by which half or third scale models of machines may be tried in the air, so obtaining results closer to those applicable to the full scale machine than can be expected from a toy model in a wind channel. There is the further consideration that it may add, in ways that cannot as yet be anticipated, to our knowledge of the nature of that atmospheric turbulence in all directions which Mr. G. I. Taylor has shown to be present in a normal wind, and the possibility of drawing upon the kinetic energy of such movements as a source of power. It will be remembered that in Hankin's book dealing with the soaring of birds over the Indian plains a suggestion was made that the birds were able to draw upon some then unknown source of power. My own experience when flying in India was at no time aimed at an investigation of this matter, but I very well remember on one occasion, near Kohat, seeing some kites circling at a great height in the air; we flew to a point some thousands of feet below the circling birds and found at once that we were in a rising current. One must not, however, ignore the theories which have been put forward that the eddy motions which accompany a wind to a greater or less degree have a considerable kinetic energy of motion which, if tapped, would explain the soaring of birds, on the one hand, and afford, on the other, a possible means of power supply for gliders.

NAVIGATION AND INSTRUMENTS.

An important item in the year's work has been the development of the new type of magnetic compass. The earliest magnetic compasses used in aircraft were based directly upon naval practice, and, with certain limitations, they were moderately successful. With, however, the growing demand for greater accuracy in reading courses, the higher speed of aircraft, and the necessity for cloud flying, it was found essential that the design should be improved. An effort was made in this direction during the war by the Royal Aircraft Establishment; their suggestions were the use of approximately spherical bowls, special methods of suspension, and, most important, for the free period of the compass to be greatly lengthened. For certain reasons these developments were not generally adopted, and the next important suggestion in the development of the magnetic compass for aircraft came from Mr. Bennett of Cambridge, in conjunction with the Admiralty Compass Observatory—from which we have always derived great assistance. This was an effort to obtain the requisite performance by vastly increasing the liquid friction on the magnetic element until the motion was exactly aperiodic. Subsequent experience has shown that the optimum condition is obtained by the partial adoption of the aperiodic principle, together with a modified adoption of the R.A.E. developments above mentioned. It seems likely that the magnetic compass of the future, having moderately heavy liquid damping, will provide the best all-round compass and that such models will be found to have performance greatly in advance of anything previously known, particularly in reference to steadiness in reading, even on " bumpy " days. Such new designs are in many cases aided by the use of the centesimal system of reading.

An alternative kind of magnetic compass known as the inductor compass, has been tried by the United States Government. In this a

little generator, the armature of which revolves in the earth's horizontal magnetic field, produces a minute electric current which, by certain ingenious mechanical arrangements, is arranged to indicate to a pilot whether he is flying to port or starboard of a course previously laid down. Since a device of this kind lends itself to repeater work it is being carefully watched. Should the introduction of steel construction into modern aircraft render the ordinary compass impossible, such a device as this might prove useful; so far as steel construction has yet gone it does not, however, appear that this need is likely to arise. The most successful compass for ship use is the gyroscopic compass. The problem of the development of this compass for use in the air is a very difficult one and, although experiments are proceeding, it cannot be said that success is within sight.

An important navigational problem is the provision of means whereby the pilot of a single-seater machine can obtain, whilst in flight, a sufficiently accurate knowledge of the velocity and direction of the wind to enable him to lay his course correctly. The solution of this problem is a particularly important matter in crossing the sea.

In a multi-seater machine carrying a trained observer the problem is a simple one since the undivided attention of the observer can be given to the making of exact observations, and their accurate reduction. The pilot, however, is able to give only partial attention to the taking of such observations and necessarily they must be of the simplest. The solution of this problem for the single-seater pilot is being attacked and preliminary flights show great promise.

Again, night flying and the ever-increasing radius of action of civilian aircraft, enhances the importance of the question of the accuracy with which these distances can be navigated. By day, provided that suitable land were always in view, the problem would not differ materially from the ordinary dead-reckoning navigation used over comparatively short distances. This assumption, at the best, would only be applicable to a portion of the route, since the pilot is liable to be required to fly over desert and sea. The pilot, however, should always be prepared to take advantage of favourable winds and conditions which may prevail above clouds, and to fly for several hours on a correct course without viewing land. This is the ideal at which we must aim, and anything less is a compromise. Either directional wireless or astronomical observations can be used. The latter necessitates accurate observation and facile reduction; the main problem is to determine, by day or night, the altitude above the horizon of some heavenly body. A sextant which experience has shown to be capable of being employed under air conditions is the R.A.E. bubble sextant. This instrument refers to the altitude of a heavenly body to a gravity-controlled bubble. The only error of importance to which the instrument is subject, is due to horizontal accelerations, resulting in a movement of the "apparent vertical," and this error is being attacked. The work of Prof. B. M. Jones has been of great value in this respect.

Landing in Fog.

The problem of landing in a fog is one of the most troublesome which we have to face. The situation at present is that an aircraft can be led to within approximately two miles of an aerodrome by directional wireless. When the aircraft is within this radius, further position-finding becomes difficult owing to the time required to take the bearings and to transmit the information back to

the aircraft. A scheme is being tried at Croydon whereby the position is rapidly taken by sound, and the information transmitted to the aeroplane by wireless. This method relieves the pilot of the necessity for asking for his position by wireless at a time when he is much occupied with flying the machine; moreover, by it the lapse of time between taking his position and giving him the information is reduced.

By these and other means (such as rockets) a pilot can locate the aerodrome, but the problem of actually landing through the fog remains. We are now investigating the possibility of laying a cable round the aerodrome, in the general shape of a race track, that is to say, with two long straight sides, the ends being curved to an arc convenient for an aeroplane in flight to follow. The cable will carry electrical current, and the aeroplane will carry apparatus capable of detecting it and of measuring the energy received. The amount of such energy gives an inverse measure of the height. By this means it is hoped to enable the pilot to locate the actual confines of the landing ground and finally to glide down, even in conditions of very low visibility, with an accurate knowledge of his height at any given moment. This method suffers from the disadvantage that in the aeroplane apparatus has to be carried which will only be used for a few minutes on a small minority of flights. It is a very difficult problem and there are disadvantages in nearly every solution. Electrical methods of fog dispersion are, as was mentioned a year ago, being tried on a small scale, and have given certain results. Artificial fog in a room can be cleared in a short time—say, one minute—to what appears to the eye to be a negligible quantity. Actually, however, the residue would be sufficient to reduce visibility in the open to some 100 yards or so, and this residue would, it is thought, take a long time and a lot of power to disperse. This, coupled with the fact that all fogs appear to drift in a greater or less degree, renders the problem very difficult.

Aerial Survey.

The value of aerial survey is largely dependent upon the accuracy with which the camera can be held vertical and at a known constant height. To determine the probable degree of accuracy a series of experiments has been carried out by Prof. B. M. Jones and Major J. C. Griffiths; the method consists of photographing a strip of flat and conspicuously marked country. From a comparison of the photograph and a map of the country, the tilt of the camera, and the height above ground, may be checked by noting the relating distortion of opposite sides of the plate and by a comparison of the scales of map and plate.

The progress made in the art of aerial photography may be gauged from the fact that whereas in 1914 it was barely possible to identify men in photographs taken from 3,000 feet photographs have now been taken from 8,000 feet in which it is possible to distinguish birds feeding on the ground. Hitherto it has been necessary to use plates in aerial cameras. A film camera is now under development, which, if successful, will save weight and space. At present we are dependent for our supply of film on sources which are outside the British Empire. This is a factor which must be taken into account before a film camera can be standardised.

Foreign made flying and engine instruments for test purposes have now been replaced by a complete series of British instruments of equal or greater accuracy. This is the first time that precision recording

instruments of this nature have been produced entirely in this country. British instrument makers have assisted very greatly in the development of aircraft instruments, and a high standard of accuracy and robustness is now being achieved.

Wireless.

Progress is being made in the use of fixed wireless aerials in aircraft, the advantages as compared with trailing aerials being considerable. They are particularly applicable to large aeroplanes, and it is considered that they will be of special utility to civil aircraft. Such aerials are operative even when an aircraft is taxying, and will facilitate "position finding" under conditions of very low visibility, and also fog landing, when a trailing aerial could not be used.

Progress in our knowledge of directional wireless continues. The plains of Iraq, and the Middle East generally, are proving ideal for this work, the errors in bearings from natural causes being negligible. Stranded aircraft can, therefore, be located with confidence and use will be made of this fact.

The abolition of accumulators in aircraft on account of their weight is a difficult problem which has received much thought during the past year. The two main difficulties are to drive wind-driven generators at constant revolutions irrespective of the air speed of the aircraft and to provide a source of electric supply to aircraft when stranded. Both these problems are now well on the way to solution.

MATERIALS.

As was pointed out at the last Air Conference, the essential difference between the work of designing aircraft and of other general engineering structures lies in the extreme need in the former to work to an exceedingly close weight limit. This demands a correspondingly closer study of fatigue limits in the materials employed. This most essential study becomes of quite vital consequence in parts subjected to alternating stresses. Research work on the fatigue problem is in hand at the Universities of Oxford, Birmingham, Edinburgh, Liverpool, at the Greenwich Naval College and at the National Physical Laboratory and Royal Aircraft Establishment. In order to co-ordinate work of the kind it is necessary to ascertain whether the methods of test at each research centre are such as to ensure similar results being obtained from similar tests on similar materials. To investigate this one half of one set of samples was sent to Dr. Hatfield and the remaining half to the National Physical Laboratory. The tests, when subsequently compared, showed closely similar results and gave increased confidence in the methods. An important detail, the failure of which is all too common, is the engine valve spring. A research is accordingly in hand to ascertain the nature of the right limits of stress for such parts.

Research work in fatigue has been mainly carried out on steel samples, but as a control experiment, tests have been made on the simpler material, nickel; these have most remarkable results. During fatigue tests on a rotating specimen of nickel, definite "heat bursts" occurred at definite loadings, but did not recur when the test was repeated on the same sample. Prof. Jenkin of Oxford has made a careful study of the bearings of this and of other similar phenomena: as a consequence he has been led to a definite theory of the nature

of the stress effects on a mass of crystals. A large scale model illustrative of this theory has been constructed and put under test. With this model almost all known phenomena in the fatigue of metals can be reproduced and the curves so found show a remarkable similarity to those obtained from actual metals under fatigue stress. The work is in some ways analogous to that leading to Ewing's famous magnetic models and promises to be equally important as an advance in scientific knowledge. To aeronautical design it may well prove to be no less important.

As is well known, the addition of every pound of unessential weight to aeroplane equipment has to be paid for drastically in original cost and subsequent running charges. Efforts have therefore naturally been directed towards the use of light materials in the construction of such equipment. For instance, in the case of aeroplane instruments it is considered feasible to make use in certain cases of duralumin parts, coated as necessary with some preservative. Assistance has been received in this direction from the Imperial College of Science, where Dr. Bengough has developed the very promising anodic oxidization process. Other workers are also engaged on similar research. Last year mention was made of the favourable experimental results obtained by the use of petroflex, in place of " petrol-resisting " rubber tubing for conveying fuel from tanks to carburettors. Development work during the year has on the whole tended in the direction of using metal tubing and metal connections in preference to either alternative; but no final decision is yet possible. In the matter of materials generally much help has been given by the British Engineering Standards Association.

INSPECTION METHODS.

Considerable attention has been paid to problems relating to the manufacture of aircraft and engines, as distinct from the question of design and the introduction of new materials.

Great difficulty has been experienced in obtaining steel suitable for the manufacture of stampings and forgings for aero-engine parts such as connecting rods, crankshafts, etc. The stampings required for the modern high-power engine are difficult propositions, and steel of absolute soundness and practically free from inclusions is necessary to withstand without cracking the severe treatment given to the material during the stamping and heat treating operations. Such steel can only be produced by the exercise of the greatest care in the selection of the base materials, in the production of the ingot, and in the subsequent operations. Every precaution must be taken to ensure that all the defective and segregated portions of the ingot are removed. Further research on the production of sound and clear steel suitable for air work is required, and is being carried out. A considerable amount of work has been done on the production of alloy steel strip for all-metal construction. The strip is supplied heat-treated, and is drawn, rolled, or formed in this condition. Great care is necessary in order to obtain material of uniform physical properties throughout, and possessing the high tensile strength required, with the ductility necessary to enable it to be worked up into members of complex sectional form. Further research is necessary to determine the physical constants for such strip, and also in developing alloys generally suitable for all-metal construction.

Attention is being given to the drop forging and die casting of large pistons, crankcase parts and so on, to obtain greater consistency

and reliability Results obtained with high silicon alloys, providing close texture and greater freedom from casting cracks, are very promising.

The serious internal corrosion of engines held in store has been eliminated to a large extent by running them with a heavy mineral oil lubricant for a few minutes on completion of the ordinary test, and turning them every two or three months at a sufficient speed to re-distribute the oil.

Advantage has been taken of recently gained knowledge of the essential qualities and properties of fuels. In the new petrol specifications issued by the Ministry, chief consideration has been given to the aromatic content of the spirit, rather than to the specific gravity. Further steps in this direction, however, must await the complete disappearance of rubber jointing, owing to the rapidly deleterious effect of aromatic fuels on such connections.

Experience gained on the re-inspection of tanks and radiators and other components in which soldering operations are employed in the manufacture has shown that the question of soldering fluxes requires research. Investigation has shown that the corrosion traceable to this source is primarily due to the presence of free zinc chloride. As this salt is soluble in hot water an additional operation of thoroughly washing the component in hot water has been instituted. The control of free acid in zinc fluxes has also been developed by the use of methyl orange. Investigations have also been made into the presence of chlorides in fibre washers which have been found to be responsible for corrosion and seizing of the adjacent fittings.

The development of the metal propeller, which at the moment is dependent upon welding during its manufacture, has called for considerable amount of research to ensure the reliability of the welded joint. This has only been achieved by the extension of laboratory methods into the shops, namely, the control of each welded propeller by means of micro-photographs of the welded joint after heat treatment. Research has also been conducted on the temperature variation in the muffles in which these airscrews are normalised. This consisted of exploring the temperatures at the various positions of the furnace and re-arrangement of the muffle to remove "hot spots." A very great improvement has been obtained as a result of these researches as regards the structure of the material adjacent to the weld.

The application of the spectroscope has been very successful in the examination of metals. The examination of the ultra-violet spectra of metals has shown the presence of traces of unsuspected impurities. A sample of electrolytic copper was found to contain magnesium in such small quantities that they escaped detection in the ordinary processes of chemical analysis. The presence of nickel has also been determined by this process. It has also been found that the absorption spectra of photographic filters offers the only reliable method of comparison for filters of the same colour. The visible absorption spectra of the green and red navigation-light glasses offer a rapid means of checking both colour and composition of the glass.

The use of polarized light has been found to be very satisfactory for the purpose of examining the navigation light domes and pulsator glasses for good annealing. Considerable difficulty had previously been experienced with these glasses owing to their liability to crack spontaneously or on the slightest provocation—*e.g.*, vibration, owing to incorrect annealing.

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A new development took place this year and will be repeated in connection with the practical tests under sea-going conditions of the various types of boat seaplanes produced under the research programme. Success was achieved as regards moorings and valuable data gained as to seaworthiness.

We are inclined to believe that in the important question of float versus boat that there are distinct uses for both, the boat being adapted for large craft and the float for lighter craft.

Steps are now being taken to investigate the possibilities of the metal hull, as it appears certain that true development for very large machines must take place along these lines. The investigation of hull forms is proceeding, as finality has by no means been assured, and valuable work on these, including hydrovanes, is being carried out by the National Physical Laboratory.

A floating dock has been produced and has proved sufficiently successful to enable investigations to proceed further.

APPENDIX I.

Summary of the Main Advances made during the Year.

1. The staff at the Air Ministry has been reorganised. Nucleus for technical administrative work has been held at Headquarters, the balance of the technical staff being transferred and amalgamated with the Royal Aircraft Establishment staff.

Another important change is the bringing in to Headquarters, directly under the Air Member for Supply and Research, of the Secretary of the Aeronautical Research Committee, who is granted free access to technical papers. It is hoped that this will facilitate the work of the Aeronautical Research Committee.

2. The metal aeroplane has now passed through the experimental stage and is fit for production; (p. 54 *supra*).

3. The supercharger has been flown with satisfactory results. Development is rapid.

4. Undercarriages of large shock-absorbing capacity have been made whereby without any appreciable increase in weight it may be possible to glide on to the ground without flattening out and, further, to reduce the risk of damage to the aircraft and crew in a bad landing; (p. 53).

5. Fuel injection. Very satisfactory progress, although perhaps slow; (p. 50).

6. Multi-engined aircraft. The three-engined machines have been explored and specifications have been prepared.

7. Progress has been made in our knowledge of corrosion of metals and the prevention thereof; (p. 60).

8. Heating and ventilation of civil aircraft.

9. Metal propellers and variable pitch propellers; (pp. 49, 52–3).

10. Fire prevention, including outboard tanks under top wing.

11. Delegation of certain stressing work to approved constructors (civil aircraft).

12. The inverted engine; (pp. 49–50).

13. Correlation of wind channel experiments with full scale results; (p. 52).

14. Universal magneto; (pp. 50–1).

15. Stalling speed experiments; (p. 51).

16. Mechanical power for controls.
17. Variable camber gears, including slots and adjustable trailing and leading edge; (pp. 53–4).
18. Metal construction of aircraft and materials for the same; (pp. 54, 58–9).
19. Improvement and initiation of navigational instruments of all types for aeronautical purposes; (pp. 55–8).
20. Wireless; (p. 58).
21. Aerial photography and aerial survey; (p. 57).
22. Method of inspection established with regard to materials has been standardised; (p. 59).

APPENDIX II.

Notes on certain Points raised at the Air Conference in 1922.

"*It has been customary to apply the results of model tests to full scale wings in order to find out how the planes are loaded in the various conditions of flight. We know that this is not strictly correct, and that the centre of pressure is generally further forward on the full scale than on the model. More exact knowledge of this subject would enable us to proportion the structure of the wings in a more economical way*" (* p. 56). I have referred to this question of the comparison of model tests to full tests in the body of this address. The solution of this point as regards the centre of pressure depends upon our success in the full-scale tests which are now in hand.

"*The method of calculating the stresses in aeroplane structures . . . It is generally assumed that incidence bracing takes no load . . . it is possible that redundant wires may actually weaken the aeroplane and not strengthen it, and research into the method of calculating the strength of aeroplane structures will certainly lead to improvement in design*" (* p. 56). That has been gone into, and we now say that, for orthodox machines, it has been decided to rely on the main bracing wires only. Incidence wires are in addition to the factor of safety laid down.

"*Problems of the engine designer. . . . It certainly seems that research is needed to find out how to produce with regularity alloy steels of a higher quality than 55 tons to the square inch tensile strength*" (* p. 56). Our reply is that our investigations do not justify the employment of steel exceeding 60 tons ultimate tensile strength.

"*The methods of soldering, brazing and welding have always been largely shop processes. There is little information to be had on the subject, and as these three methods are constantly used by all aeroplane constructors, further knowledge would be of advantage*" (* p. 58). As regards soldering and brazing, the most recent specifications for aircraft components lay down instructions as to precautions to be taken. In reference to welding, an Air Publication (No. 880) has been issued.

"*Research might be instituted to determine how best to work materials to get them to required shape, and in certain cases how to treat them after*

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* The references in Appendix II. are to the "Proceedings of the Second Air Conference held on 7th and 8th February 1922." (Cd. 1619; H.M. Stationery Office, 1922, 3*s*. net.)

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work without causing deformation. The best method of preventing corrosion also needs investigation, particularly if we are to use metal construction" (* p. 58). Much has been done during the year in conjunction with aircraft contractors and steel makers as to the best methods for producing steel strip to required section. As regards corrosion, we have definitely advanced, and we can say that, provided certain precautions are taken, duralumin can be used. As regards other metals, definite progress has been made.

"*Safety from fire both in flight and in case of accident*" (* p. 59). The majority of the recommendations of the Fire Preventions Committee of the Aeronautical Research Committee have been adopted.

"*The user is much interested in the comfort of his passengers, and in this matter the silencing of the engine and airscrew is of importance*" (* p. 59). Considerable investigation has been made. The noises can be reduced to three causes, namely, exhaust, propeller, and the engine itself. Of these a satisfactory method of silencing the exhaust of a water-cooled engine has been achieved, without undue loss of power and without appreciable increase in weight. There remain the two other causes, which are being investigated, but which are not so easy by any means.

"*Research is required into the matter of airscrew silencing*" (* p. 104, col. 2). No definite solution has yet been found regarding propeller silencing.

"*At present designing firms are not given facilities for testing out new machines ordered by the Government, and cannot afford in these tests to take full risks themselves. I feel confident that if reasonable facilities could be given for a series of tests to be carried out by designing firms, it would result in greater satisfaction to both sides and would enable definite data to be gained in the shortest possible time*" (* p. 105, col. 1). As regards the risks of contractors, the Government takes the entire risk of flight as regards aircraft constructed to Government orders; in addition, the time of the test flight at contractors' works has this year been increased to three-and-a-half hours, which means a considerable extra expense, not constructive, but general.

"*The cause of engine stoppages demands immediate urgent investigation . . . by the analysis, tabulation and classification of the causes of all those which occur*" (* p. 107, col. 1). That matter was investigated during the year, and it was found that it was impossible to give an analysis of every sort of engine failure, but in all serious cases that come to our notice a return is now made to the Aeronautical Research Committee, and every single case that occurs on the civil air routes that can possibly be noted is also sent to the Committee.

"*Knowing the total resistance of the aeroplane, the power required can be settled when we know the efficiency of the propeller. This is a matter on which research is needed, particularly on the efficiency of the propeller in relation to an aeroplane body. This seems to be an excellent example for comparing wind-channel results with the full-scale results which can be obtained by the use of a thrustmeter on an actual aeroplane*" (* p. 54). A torque meter has been manufactured and has been used in flight, and reasonably good results have been obtained. This being a first instrument it is not perfect. Development progress is in hand. A combined torque and thrust-meter has also been made

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and is now being calibrated, and with these two instruments very valuable results should be obtained.

"*Another matter which affects the resistance of an aeroplane is the power used in cooling the engine. We are still uncertain whether it takes more power to cool an air- or water-cooled engine, and in the case of radiators we are quite at variance as to their most economical arrangement. Research is needed in this matter, and it should probably be carried out in connection with the efficiency of propellers mounted on suitable bodies*" (* p. 55). Experiments have been in full swing at the Royal Aircraft Establishment throughout the year with regard to radiator tests; with regard to heat losses, except for a brief period, the tests have been continuous. A great deal of work is entailed in compiling the results obtained, and they cannot well be put forward until the whole of the experiments in the programme are complete. It is hoped that the results will be available in about six months' time.

"*Metal Construction. . . . The present difficulty is, that in order to make parts suitable for aeroplanes the thickness of the material has to be small, and we have yet to find out the best methods of making and using thin sheet metals*" (* p. 55). A satisfactory method of using thin sheet metals is now known and machines are being built on this principle.

The CHAIRMAN: My Lords and Gentlemen, I am sure that we have heard a very gratifying statement from Sir Geoffrey Salmond. It shows persistent research work during the year and will receive the attention of the members of the Conference to-morrow, when Sir Geoffrey will probably be plied with questions not dissimilar to those which he has had to answer to-day and which were asked a year ago. I will now call upon Colonel Ogilvie to read his paper.

GLIDERS AND THEIR VALUE TO AERONAUTICAL PROGRESS.

Colonel ALEC OGILVIE, C.B.E., F.R.Ae.S.: Mr. Chairman and Gentlemen, after hearing the impressive statement made by Sir Geoffrey Salmond—in whom I am sure we all have complete confidence—one would think that everything in his garden at any rate is growing beautifully. I wish that I could think the same of our poor little vegetable patch.

It is not the intention of the writer of this paper to give a history of the many gliders which have been built, with details of dimensions and with the flying results attained, as this would appear to him likely to bore his distinguished audience and not to be in accordance with the spirit of the annual Air Conference. He proposes, therefore, to touch as briefly as possible on the actual experimental work with gliders, but to spend more time in drawing attention to the relation of this experimental work to the aeronautical knowledge of the day.

Early experiments.

The interest of men in the flight of birds goes back to very early days, and although "to fly" was commonly considered to be an impossibility until quite a few years ago, numberless men watching birds sailing along with motionless wings have expressed their disbelief in the impossibility of such a feat for human beings. One reads legendary tales of magicians, or in other words, the scientists of the day, who distended their cloaks with their wands and flew from towers or other high places. If they were fortunate enough to survive the

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subsequent fall, the populace would set upon them and complete the good work.

There can be no doubt that in several cases, some many hundreds of years ago, attempts to glide met with partial success, and it is noteworthy that such attempts to imitate a bird in gliding flight were the only ones of innumerable efforts with helicopters, with beating wings and with power-driven aeroplanes, to reach any degree of success at all. It is probably not too much to say that if the early experimenters had not tried to go quite so fast, they might have made quicker progress, and flight might have been accomplished a considerable time before it was.

Nothing is more astounding to a student of aeronautical history than the immensity of the effort in money, in time and in brains of a high order of excellence, which have been put into abortive experiments in aeronautics.

These experiments ranged from model flying machines, which were frequently successful, to full scale efforts which were invariably failures. The reason for these failures is to be found in the essential difficulty in making the first flight. As it was not thought possible to work up gradually to a successful flying machine, numerous problems of lift, resistance, power, stability, control and starting all had to be solved simultaneously and failure in any one particular caused failure in the whole.

Among those who were specially attracted by bird flight was a French sailor named Le Bris, who on his sea journeys about the world, watched the albatross flying for hours without effort, and was so inspired by the sight, that on his return to France in 1855, he set to work and built a glider on the same general lines as an albatross and large enough to carry himself. This remarkable machine was a monoplane of some 50 feet span with sail like wings, and was launched into the air by being carried against the wind on a cart, from which it could be freed by a ship's rope. It was so effective that it lifted into the air not only Le Bris himself but the carter, who, by an accident, became entangled in the dangling rope. This event took place long ago, but there is no doubt that Le Bris did actually make a brief flight and a safe landing. He subsequently attempted other glides but none were so successful as the first.

Twenty years afterwards, another man, this time a German and an engineer, Otto Lilienthal by name, became convinced after studying the flights of storks, that the principal obstacle in the way of human flight was lack of practice in the art of flying itself. After a series of laboratory experiments lasting several years, with wing sections of various shapes and curvatures, Lilienthal embodied his results in a glider, or rather a series of gliders, with which he made at least two thousand flights between 1891, when his full scale experiments commenced, and 1896, when he was accidentally killed.

The importance of the work of this man to the progress of aeronautics cannot be over-estimated, in fact he is justly considered to be the originator of the modern flying machine. It is easy to find fault with the details of Lilienthal's glider, with its badly shaped wings, and its weak construction, and its almost total lack of control, both longitudinal and lateral, but none of these details can detract from the importance of his principal idea, which was that full scale practice in the air was the first step to be taken. He was the first genuine experimenter to point out the right path and he did so in opposition to the general aeronautical opinion of the day. During this

period, 1890 to 1900, there was a very great deal of aeronautical work going on. In France, Ader was working with the strong financial support of the French Government, on a large 40-h.p. steam-driven "avion," fully expecting that the machine would fly and become an important national asset. In England, Maxim was experimenting with a gigantic aeroplane, about 150 feet long by over 100 feet wide and driven by an engine of 300 horse-power, and he also was fully confident of success. In America, Langley and a highly trained staff, had been working for years on aerodynamic research and were making continuous progress with large model flying machines, as a preliminary step to a full sized machine.

These are the three most striking cases, in which very large sums of money and the best available talent were being expended with full confidence of success. Other names, household words in aeronautics, such as Hargrave in Australia, Phillips in England, Tatin in France, Kress in Austria, and many others were hard at work experimenting with all kinds of different apparatus. Nevertheless, the writer would be inclined to assess the total sum of the whole of this experimental work as of less actual value to aeronautics than that of Lilienthal's gliders.

The same line of thought was taken up by Chanute, a distinguished American railway engineer, who saw the bad points of Lilienthal's machine. In place of the weak bat-like wings of his predecessor, Chanute substituted a trussed biplane of small chord and fairly considerable span. But although he made considerable technical advances over Lilienthal, he was not successful in overcoming the latter's principal difficulty, that of obtaining really adequate control over the machine in the air.

Pilcher, an Englishman, carried on Lilienthal's work, but though he sacrificed his life in his experiments he made no substantial technical contributions to the problem which had baffled the men before him.

The lack of success with all these attempts at flight, although some had been conducted on the most elaborate scale and backed with large means, had so discouraged the various experimenters and the world at large that we find, about the end of last century, the general aeronautical opinion of the day giving up its immediate hopes of flight with aeroplanes and turning to the navigable balloon, influenced, no doubt, by the striking success of Santos Dumont, whose small dirigibles were causing great excitement in Paris.

When the Wright brothers took up gliding, they did so purely from a sporting standpoint, but they showed from the beginning that they had a very clear grasp of the problem, and that they appreciated that the heart of the difficulty was control in the air, both lateral and fore and aft. Their machines were simply-made biplanes of ample strength, the design of which progressed from year to year as knowledge of the requirements was obtained.

This problem of control turned out to be far harder than they had anticipated, and it took these two very exceptional men three years work with gliders and models before they dared to attempt flight with a power-driven machine. Before this could be successful, they had with their limited resources, to make a sufficiently light engine, to design propellers with a system of transmission, and to build the aeroplane itself big enough and strong enough to carry the engine and fuel as well as the pilot, They had also to work out a method of getting the aeroplane safely into the air. When one considers the

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innumerable failures with power-driven aeroplanes up to that date, a successful flight would appear to have been a very formidable task, but it only took one year against the three years required to solve the control problem.

The deduction which the writer would wish to make from this is that the control problem might well not be solved at this present day, if it had not been for the availability of the glider as an instrument to get at the fundamentals of the problem in a simple, inexpensive and reasonably safe manner. Once the fundamentals are known, their application to attain practical results is quick and easy.

Development of practical flying.

Although the Wrights made their first flights at the end of 1903 it was not till 1908 that their machine was really shown to the public in Europe and in America. Meanwhile, taking Hargrave's cellular box kite as the basis of design, the French had made progress. The reliable Gnome motor appeared, and combined with the stimulus given by the example of the Wrights' perfect control in the air, the rate of progress was greatly accelerated and it became obvious to everyone that the aeroplane was a practical success, with great possibilities for the future and particularly for military purposes. Nevertheless, the inevitable inertia and lethargy of the various national War Offices were so great that the most active assistance at this time came not from the governments but from private individuals. In general, the experimenters of those days were private persons, motor engineers, men without very large resources, and what encouraged them and kept them going through innumerable set backs and disasters were the prizes offered by business men, by newspapers, and by public bodies, who put up sums of money for competition under various conditions framed so as to advance the science, and at the same time, reward the aviators. The effect of all this was a very rapid technical progress in the aeroplanes, in the engines, and in accessories. After a year or two the authorities woke up, and started their own experimental organisation and air services, and by the outbreak of war were more or less technically ready for the big expansion which immediately followed.

During the war period, lives, brains, and money were freely expended to meet the rapidly increasing requirements, and the expansion in the four years was to be measured in hundreds of fold. If the war had continued for another year or two, it was to be expected, judging by the rapid rate of progress, that the aircraft weapon would have predominated over all others.

From the technical standpoint the necessity of maximum performance in speed, in climb and in weight carrying was so paramount that other aerodynamic qualities were perforce neglected. It was futile to spend much time in improving any particular type of machine, in the direction of better control, or of greater economy or safety, when the same result, or nearly the same result, could be obtained by putting a more powerful engine into the same machine or by designing another machine to take the bigger engine. Demands upon the pilots for greater skill in landing and in controlling their machines were promptly met.

Another noteworthy result of this intensive activity in design was the standardisation of such wing sections as gave specially good results from the performance point of view. This standardisation was to be noticed in all the combatant countries, but particularly

in this country. The demands for faster and more powerful aeroplanes were so continual, that it was considered by designers wiser to concentrate their attention on a wing section which could be relied upon to give the results expected rather than to embark upon untried sections, whose qualities on the full scale might necessitate lengthy experimentation to develop their particular advantages.

Judging from some recent trials, details of which the writer is not at liberty to give, it would appear that it is fully time that the designers of this country should seriously turn their attention to wing sections other than the standard ones. The writer has a clear piece of evidence that very considerable improvements in all round results can be obtained with a thick sectioned monoplane over the thin sectioned biplane practically standardised in this country.

The methods of construction developed in the war period were suitable for the rapidly changing types which were produced to meet rapidly changing demands, but which were out of date almost before they were in production. As might be expected, such types of construction did not primarily make for reliability, ease of maintenance, or for long life.

The aircraft industry, under these conditions, developed in the most amazing way, but having only one customer, found itself in a very difficult situation as soon as the demands of that one customer fell off.

Since the war all that the customer has been able to do is to dole out orders just sufficient to keep the industry or part of the industry alive.

Present Position of aeronautical development.

It must be understood that the writer is looking at this matter from the point of view of aircraft for civil transport purposes. From this standpoint, the present position of aeronautical development cannot be considered to be satisfactory.

Civil aircraft are not sufficiently safe in the event of a breakdown of the motive power, necessitating a forced landing. Undoubtedly some types are safer than others, but in all the demands on the pilot are too severe, and the risk of an accident too great.

Present day civil aircraft are also much too expensive to buy, to run and maintain in running order, and until very considerable improvements can be effected in these respects, it cannot be claimed that they are transport vehicles of a really commercial character.

It is hoped that these remarks will not be misinterpreted. The writer has a firm belief in the future of civil aviation and in the capacity of our aircraft industry to find an answer to the many problems involved.

The difficulties under which civil aviation in this country is labouring are very great, considerably greater than in some other countries, but there appears to be firm determination and a desire to develop the design of aircraft and the technique of maintenance on such lines as should ultimately lead to a machine which could fairly be considered to be a self-supporting commercial proposition. The system adopted in some countries, of encouragement of the production of aircraft from the point of view of numbers rather than of economic quality, is one which receives little or no support from responsible persons here.

The size of commercial aircraft is so great that the cost of buliding such machines for experimental purposes is practically impossible to private firms, apart from the cost of the large quantities of fuel

required, of the maintenance parties, and of the large shed accommodation and other overheads.

State support of the experimental work of private firms necessarily means a measure of control of that work, and this is not, in fact, and cannot hope to be, really satisfactory because the firm who has initiated and is conducting the experiments must be free to follow out its own ideas in its own way.

The position is, therefore, somewhat of a deadlock. It is impossible to make rapid progress towards a really sound economic aircraft without a large volume of experimental work, the cost of which, if conducted on the full scale, is so great as to be altogether beyond the capacity of the transport firms or of the industry.

Recent Experiments with Gliders.

After this short account of the general aeronautical position, we can return to the subject of this paper and briefly review the glider experiments of the last few years.

The post-war restrictions placed upon civil flying in Germany, directed the energy of her aeronautical engineers into the channels of research and experimental model work, with a revival of interest in gliding as a means of full-scale testing of wing sections and new methods of construction. Prizes were offered and some remarkable results were achieved. Interest was principally directed towards the maximum duration of a glide, which appeared to be a simple method of testing the qualities of the various machines. These were flown in an up current caused by the wind blowing against a hill, and as long as the vertical rate of rise in the wind current was greater than the vertical rate of fall of the glider, the latter was able to maintain its position. So stated, it would appear simple to make indefinitely lengthy flights, but the difficulties experienced were principally ones of keeping control over the glider in the large variations of wind velocity and direction and of keeping a position in the best up current.

These difficulties had, in fact, been the principal ones experienced in 1911 by Orville Wright and the writer, when they were experimenting with a glider at Kittyhawk. The longest glide at that time was just under 10 minutes, and took place in a high wind of about 40 miles per hour. The experiments in Germany were carried out in much lighter winds, 15 to 20 miles per hour, and on the face of a hill with smaller gradients. These conditions demanded a considerably higher degree of aerodynamic efficiency and it was not until 1921 that flights of 20 minutes were made.

The interest in these feats was, nevertheless, world-wide and 1922 saw the maximum duration extended to one hour and then to two hours.

France organised a competition in which a very large number of gliders took part. The results were not very striking, and no very long flights were made. It is probable that the locality chosen for this competition had a great deal to do with the length of the flights. In fact, recent experience has shown that the duration of flight of a glider which has the right conditions is only limited by the fatigue of the pilot. While the French competition was actually in progress the Germans beat their own record by a flight of over three hours.

In this country these experiments were watched with much interest but with no very tangible results until the "Daily Mail" put up a prize of £1,000 and asked the Royal Aero Club to conduct a compe-

tition for the longest glide under certain conditions which were laid down.

This competition took place at Itford and created widespread interest, and opened the eyes of people in this country to what had been going on abroad.

Fortunately the wind blew from a suitable direction and with suitable strength and some remarkably good flights took place. Within two days a flight of nearly two hours had been made on a British monoplane, and before the end of the week the German record had been beaten in a flight of 3 hours 20 minutes by a French machine.

The landing after this flight was made almost in the pitch dark, and when it is considered that the type of machine was a most unconventional one with a novel form of control, and that the only previous glide had been one of a few seconds, there can be no doubt that this performance was a very remarkable feat on the part of the designer and of the pilot and one most significant of the possibilities of the glider as a method of experiment.

As events turned out, the competition was one of controllability rather than of efficiency, and meritorious as were the British machines in some respects, it was evident that there was room for improvement in controllability.

As far as the writer is aware, none of the competitions have demonstrated what is the true gliding angle or overall efficiency attainable in a modern glider. All that can be said is that one machine looks better than another in this respect. It has been said that there are gliders whose angle of descent is only 1 in 15, or even 1 in 20, but the writer has seen no proof as yet that any glider has accomplished, in fact, an angle even as good as 1 in 12. It should not be difficult to work out a method of experiment determining this with reasonable accuracy.

Limitations and Usefulness of Gliders.

There would appear to be very little likelihood that engineless aeroplanes can ever be of practical service in journeying from place to place, or even that they will be much used for sport. The necessity of an up-current of some kind to support the machine renders the first almost impossible, and confines the second to special localities. The sport of motor cycling would be a tame affair if it was limited to hill climbing up special hills.

There are possibilities in the use of gliders for purposes of training pilots, and there are certainly possibilities in the development of small sporting machines of 15 to 20 h.p. capable of horizontal flight with, say, 5 h.p. and doing 100 miles or so to the gallon, but the real immediate value of gliders lies, as it always has done, in the opportunity they afford of technical experiment in a simple and inexpensive manner.

In experiments with engine-driven aeroplanes, the horse-power of the engine and the efficiency of the propeller are always difficult to estimate exactly. The detail design has to be carried out with care and attention in order to keep the percentage weight of the structure within fairly close limits, while the cost of the experimental work is almost prohibitive to private firms.

On the other hand, with gliders, the motive power, which is the force of gravity, is perfectly definite in amount and always reliable, and for many purposes the machine can be built in a simple, rough-and-ready manner as long as the external form is correct.

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As already indicated, there are two main technical problems in the commercial aeroplane of the day, and it is suggested that solutions of either, or of both, are more likely to be found by means of experimental work with gliders than by other means.

The first is the increasing of aerodynamic efficiency, to enable considerably greater loads to be carried for the same power, or the same load for less power. The overall efficiency, the ratio of lift to drag, or, in other words, the inverse of the gliding angle of the commercial aeroplane of the day is about 8 to 1, in some cases even less. To put the result in another way, about 60 horse-power is required to carry each individual passenger for the usual 3-hour journey at a speed which is necessary to combat the normal wind conditions. This 60 h.p. per passenger is obviously a very high figure, and gives an indication of the reason for the high cost of aerial transport. It should be noted that in addition to the heavy fuel costs entailed by the poor efficiency, there are heavy capital and insurance costs, all of which would come down if the overall efficiency could be increased, as it is perfectly certain it could be provided that an adequate amount of experimental work can be done.

The second problem for solution is the improvement of controllability at low flying speeds, so that in the event of an engine stoppage, the aeroplane can be landed in awkward fields with greater safety than at present.

It is well known to aeronautical engineers that an aeroplane, the stalling speed of which has been tested to be, say, 50 miles per hour in good weather on a large aerodrome, is never, in the event of a forced landing, glided in at a speed of less than 60 miles per hour. This additional 20 per cent. over the stalling speed adds greatly to the difficulties of the landing and to the shock in the case of an accident, and would be entirely unnecessary if the pilot had an aeroplane over which, even in gusty weather, he had complete control right down to the stalling speed. This difficulty is such a commonplace among pilots that it does not occur to them to worry about it, but it is a problem to which a great deal of attention is being paid, and to an attack on which the Aeronautical Research Committee is devoting a considerable amount of the resources at its disposal. The recent gliding competition at Itford Hill showed how much room there was for improvement in the controllability of the aeroplanes entered, and instilled a belief that other competitions would cheaply and quickly effect much improvement.

There can be little doubt that these are only two instances out of many where we have good reason to expect substantial progress by means of experimental work with gliders.

Summing up, the principal value of gliders at the present time would appear to be as a method of experiment between the model in the wind-channel and the completed power-driven aeroplane, whereby new lines of thought in wing sections, in body shapes and in methods of control can be tried out in the air in a simple and inexpensive manner.

The writer would conclude by an appeal to business men who are interested in civil aeronautics, from whatever point of view, to put up prizes—not necessarily large ones—and so to stimulate competition among a large number of brains towards a solution of the problems which must be solved before commercial aviation, ultimately to be a necessary bulwark of the country, can become the practical

economic proposition, which is, no doubt, the hope of all present in this historic hall.

The CHAIRMAN: I am sure, my Lords and gentlemen, that we shall all join with Colonel Ogilvie in hoping that the funds which he referred to, in the last paragraph of his paper, as being desirable, will be speedily forthcoming.

I will now ask Mr. Fairey to read his paper on Seaplanes.

SEAPLANES.

Mr. C. R. FAIREY, M.B.E., F.R.Ae.S., Chairman of the Society of British Aircraft Constructors: Mr. Chairman, my Lords and Gentlemen, I think the subject of the Seaplane was included in the programme of the Air Conference chiefly to give the small brother—I was going to say, the poor relation—of the aeroplane a chance to make its voice heard; but I find that, as a title for a paper, it is far too comprehensive. In view of that obvious fact I need, I think, make no apology for having only been able to touch upon one or two outstanding features of the questions of the design and operation of Seaplanes. I have made an attempt, firstly, to classify Seaplanes, not because the various types are not fully known to everybody who will join in the discussion, but because nearly every point of design and operation is controversial. In touching every aspect of the question I have been forced to refer to it twice over in relation to each type. And, then, I have dealt with a few questions in the practical and theoretical aspect of design and operation.

It is a well-known fact that, although at quite an early stage, the design of aeroplanes settled down into practically one universal type, *i.e.*, the tractor, owing to its preponderating advantages in general arrangement and performance; the seaplane is still in an unsettled state even as regards an accepted general arrangement of components, and there are quite sharply divided opinions as to the relative merits of different types due partly to the fact that proper comparative tests under varying conditions have never been made and much that is matter of opinion to-day could, by proper full-scale experiment be established as matter of fact.

Therefore, the design of seaplanes is a subject on which it is as difficult to dogmatise as it is easy to start a discussion, and it is only possible in a general paper on seaplanes to indicate some of the problems that most effect design and operations rather than state with any confidence what are their best solutions.

The various controversies that have taken place on the subject have ranged from questions of construction to discussions as to whether the type itself has any proper function, and whether seaplanes are really of any use at all. The author has, in fact, heard it argued that since mankind does not live on the sea the sea should be flown over and not landed on, the purpose of the flying machine being to communicate from one piece of land to another, or alternatively, to a ship where it can be landed on or launched from the deck.

Of the many fallacies in this argument the principal one lies in the fact that whatever stage of perfection aircraft engines may reach and whatever effect such improved reliability of engines may have on the design and use of flying machines, the propelling power can never be of such an order of reliability as to render the machine absolutely immune from forced landings. Even in the present stage of development of a ship engines a recent paragraph in the Press showed

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that no less than 20 ships were adrift on the oceans of the world with broken-down engines within 24 hours, and since the breakdown of the power unit of a flying machine must result in a forced landing within the space of a few minutes it is obvious that the proper type of machine for flying over seas must be capable of alighting on and rising from the surface.

Apart from that important fact, an equally great advantage of the seaplane is that coastal harbours, big rivers, and inland lakes provide natural "aerodromes" from which it can be operated, and in certain districts, for example, Canada and the North of Russia, they can be used over country where aeroplanes could positively not fly in safety. Practically from one end of Canada to the other the countryside offers infinitely more safe alighting places for seaplanes than for land machines. The great rivers of the world provide ready-made routes for seaplane services from which the danger of forced landings that would beset aeroplanes are nearly eliminated, and their equivalent for aeroplanes would be a continuous chain of aerodromes of quite prohibitive cost. The great archipelagoes of the Far East and the African swamps are examples of country where the seaplane is the only practical means of flying.

From the Naval point of view, whatever may be done with specialised aeroplanes operating from carrier ships, it is ovbious that conditions will set a strict limit to size of such machines, and for long range reconnaissance at sea and for carrying big loads for offensive operations, the development of the seaplane is the all-important factor which must not be neglected.

Modern Types of Seaplanes.

As mentioned before there is as yet no settled type with seaplanes as with aeroplanes, but they may be classified into two main types —the flying boat and the float seaplane. Each class can be subdivided into further types and it is impossible within the scope of one paper to more than mention the particular features of the main divisions. Each type has its particular advantages and its particular difficulties in design and operation, but apart from certain controversial features, many of which could be settled by careful experiments, preference for one type or another is mostly dictated by local requirements. With development in size certain characteristics will become predominant and greater settlement of type may be expected.

The flying boat.

In the flying boat the superstructure is built on a single central hull taking the place of the fuselage of the aeroplane, and since the centre of gravity is nearly always above the metacentre, lateral stability on the water is provided by wing tip floats. This type has been built in sizes varying from small single-seaters, such as the Supermarine Racer that won the Schneider Cup Race last year, to the large four-engined N4 of 32,000 lbs. gross weight.

With flying boats the superstructure and arrangement of engines, according to size and power, fall generally into line with the equivalent land aeroplane, and the principal division of type, apart from the constructional methods in building the hulls, comes with the arrangement of the step and shape of the hull beneath the water-line. Although there are very few examples of what might be called the single-step hull, the second step in most hulls is so atrophied as to

represent little more than a skin wave breaker to keep the tail clean. In operation the difference lies in the fact that the single-step type at or over hydroplaning speed exerts only small trimming moments due to water pressure which can be overcome by the air controls, the arrangement being roughly analogous to the ordinary two-wheeled type of land chassis, and the fore and aft latitude of the machine when taken off and landing is under the control of the pilot, the machine not being stable as a boat unless that control is exerted after a certain speed has been passed. It has the advantage of a large angular range of movement is available to assist the machine in riding over rough water head on to sea and to prevent any tendency to burrow in a head sea, but it is very subject to "porpoising" if not skilfully controlled.

With the two-step type in which the second step is highly developed the intention is that the hull shall be stable from zero to taking-off speed and shall itself take up the best attitude when running on the water. It needs, accordingly, less skill in piloting, but has not the advantage of the single-step in the rough sea. Most modern machines have adopted a compromise between these two conditions in which the second-step is very small and the best features of both types are obtained.

Under the water-line both these types of hull vary in design from the flat bottom of the Savonia type to the sharp V of the Linton Hope hulls, as, for example, the P5. The flat type by its greater hydroplaning efficiency is easier to take off smooth water but meets with correspondingly greater impact on landing. The V-type makes much easier landings but its hump speed is higher and not so sharply defined.

A new type of German boat has recently appeared, the Dornier, in which an attempt is made to avoid the use of wing tip floats by lateral extensions on the hull in the form of buoyancy chambers which are shaped in the form of thick wing sections and are intended to give some lift in the air. For smooth water this type appears promising but could not possibly have the lateral stability of the three-float machines. Attempts have also been made in Germany, in the Oberst boats, to provide the boat with sufficient beam to avoid the use of wing tip floats at all.

In the list given an attempt has been made to classify the existing modern seaplanes into their various classes. It should be noted that both France and Italy favour the flat-bottomed hull, but that all English designs are now V-pattern.

The float Seaplane.

The float type of seaplane is in appearance a normal aeroplane in which the floats or pontoons take the place of the usual landing chassis. Actually, owing to the different distribution of masses and head resistance it is very different structurally and presents a different problem in stability and control.

There are many more variations of float shape for this type than for the boats. The principal division is the twin-float and the single-float of which the twin-float is the most popular, at least, in this country. Both single- and twin-floats type can be further divided into the single-step and two-step classes as are the boats, with an additional intermediate type with a single-step, but with a buoyancy chamber or extended stern of the float aft of the step, which provides complete or partial fore and aft stability on the water but exerts little or no hydroplaning effect, and this pattern is intended to combine the

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CLASSIFIED LIST OF EXISTING MODERN SEAPLANES.

Flying Boats.

Single-Step Type.

——	Gross Weight (lbs.).	Useful Load (lbs.).	Structural Weight.		Weight (lbs.) per H.P.	Weight (lbs.) per sq. ft.
			lbs.	%		
Besson Triplane - -	1,910	590	955	50	14·5	5·9
N.T. 2 B. - - - -	3,169	848	1,470	46	14·95	7·1
Macchi - - - -	3,540	1,100	1,560	44	14·2	7·3
Farman 450 H.P. -	6,380	2,200	2,600	40	714·2	7·2
N.C. 4 - - - -	28,000	129,000	9,800	35	16·7	11·7
Flying Boats. *Two-Step Type.*						
Supermarine Schneider Cup Winner (1922) -	3,274	800	1,110	34	6·9	—
Nieuport - - - -	3,850	1,325	1,735	45	19	7·6
Dornier : - - -	4,400	1,440	1,800	41	23·8	8·8
Savoia S. 16 - -	4,620	1,760	1,850	40	16	8·1
Supermarine Seagull -	5,680	2,000	2,180	38·4	12·2	—
Supermarine Amphibian	5,700	1,960	2,280	40	16·2	—
Viking IV. Amphibian -	5,675	1,872	2,121	37·4	12	9·4
F. 3 - - - - -	11,900	4,250	4,750	39·8	16·5	7·3
P. 5 - - - - -	12,055	4,700	4,330	35·8	16·75	—
Short Cromarty - -	19,700	7,412	7,310	37·1	18·75	8·77
Felixstowe Fury - -	27,700	11,500	9,200	33·2	15·4	8·75
Atlanta N. 4 - -	32,000	11,700	10,300	32·2	12·3	11·1
Float Seaplanes. *Twin-float—Single-Step Type.*						
P.V. 2 - - - - -	1,590	503	787	49·5	15·9	9·5
P.V. 2 Bis. - - -	1,702	491	911	53·5	17	9·5
184 Short - - -	5,400	1,020	2,080	46·3	18	6·5
Ricci R. 1 C. - -	10,000	4,000	4,230	40	15	8·2
Float Seaplanes. *Twin-float—Double-Step Type.*						
P.V. 5*a* - - - -	2,518	546	1,217	48·3	12·6	8·1
Fairey Pintail III. (Amphibian) - -	4,700	1,350	1,950	41·5	10	10·7
Caudron - - - -	6,750	2,000	3,200	47·5	17·4	7·2
Float Seaplanes. *Twin-float Type, intermediate between the Single-Step and the Double-Step Types.*						
Avro Polar Expedition	1,589	589	687	43·2	18·7	9·23
P.V. 9 - - - - -	1,965	561	960	49	13·1	8·65
Avro Viper - - - -	2,567	604	1,170	45·5	12·2	7·92
L.V.G. W. II. - -	2,650	650	1,220	46	—	—
Junkers (Duralumin construction) - -	3,120	1,105	1,100	35·4	—	—
L.V. W. I. - - -	3,460	810	1,370	39·5	—	—
L.F.G. V. 20 - -	3,475	1,275	1,320	38	—	—
Short N. 2*b* - - -	4,938	1,586	1,852	37·5	14·3	7·05
Fairey III. D - -	5,050	1,650	2,200	40	14	10
Fairey Atlantic Mark II.	7,150	3,100	2,600	36·3	20	10

advantages of the single-step as to control of the attitude on the water and of the two-step for stability when adrift. An interesting example of this type is the Bradnenburgh float much favoured by the German designers during the war in which the stern of the float is extended aft and terminates in a vertical stern-post in distinction to the flat of V-shape.

Twin floats, except for a few experimental machines, have not been built or used so much in the large sizes as the boat type, but owing to certain particular advantages are popular in sizes up to about 6,000 lbs. gross weight. It is interesting to note that the twin-float type was favoured in Germany during the war to the almost entire exclusion of every other class. In England it was much used for special purposes, but in France and Italy the boat type has been shown preference. In America, judging by the great variety built, preference seems to be equally divided, but large twin-floats have not as yet been developed, and so no comparison can be made with contemporary large boats.

The only modern representative of the single-float type in this country is the Parnall " Puffin " amphibian which is a special purpose machine, but in America a considerable variety of single-float machines are built. Although this type has a small advantage over the twin-float in structure weight percentage it has the serious disadvantage of lateral instability on the water which necessitates the use of large wing tip floats.

Special examples of float machines are the large experimental Dorniers built in Germany during the war and one large experimental example built by the Admiralty in this country.

Another principal distinction between boat and float types is that whereas the boat at least in large sizes must have a V-bottom for shock absorption on landing, the great majority of float types have flat bottomed hydroplaning surfaces, the necessary shock absorption being obtained by springing the floats relatively to the machine.

In view of a certain divergence of opinion in preference of types it may not be out of place here to go over in outline the relative qualities of the two main divisions—boat and float seaplanes.

An attempt will be made later on to show that the general average of advantage and disadvantage really sorts itself out in terms of dimensions, but broadly speaking, they may be classified as follows :—

BOAT.

Advantages.

Light structure weight.

Large reserve buoyancy of the hull.

Ample stowage room and accommodation for crew and eqiupment.

Ease of mooring and handling by crew on water.

Good view of the pilot.

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Disadvantages.

Eccentricity of centres of thrust, gravity and head resistance coupled with necessity of carrying down load on the tail.

Difficulty of beaching.

Risk of total loss through damage to hull.

Dependence on wing tip floats for lateral stability in side winds.

Twin-Float.

Advantages.	*Disadvantages.*
Lateral stability on the water.	High structure weight percentage.
Concentricity of forces with improved performance and ease of control.	Large fuselage stresses set up by floats and tail float.
Ease of handling and repair.	Difficulty in mooring and handling by crew on water.
Compartmented floats with less risk of loss through damage.	

The above apply chiefly to single-engine machines and the basis of comparison alters when applied to larger or multiple-engined types, the increase in size having the most marked effect.

In the accompanying diagram (Fig. 5*) are plotted the structure weight percentages against overall weight of flying boats, float seaplanes and aeroplanes. These will be considered later when comparing with aeroplanes, but the effect of size on structure weight should be noted in making any comparison of types.

Generally speaking it would appear that the average of advantage lies with the float types for small machines and the flying boat type for large ones; but this point of view must be modified if any one feature of either type is desired in preference to an average of superiority. Also this choice has one serious drawback, as both the single-engined float and the multiple-engined boat types have unprotected propellers, a feature which involves considerable difficulty in the design, and is the principal objection to both types.

On nearly every point mentioned the writer will have to refer to this question of boat *v.* float when features of either type crop up in relation to the other, so that it can be left to the discussion to bring out the main points at issue. The chief divergence of opinion is in the question of seaworthiness and here it is that thorough full-scale experiments could do more than debate. At the same time it is suggested that the two types are not really competitive in most respects and that both will survive for their special purposes.

PRACTICAL PROBLEMS.

Seaworthiness.

The question round which the greatest controversy has raged is that of seaworthiness and this term is not usually properly defined. The conditions of seaworthiness must first be studied and are usually totally different when the machine is under power, or if it is to be assumed that the engine has failed and the machine is adrift. The very qualities which make for improvement in the one case are frequently a disadvantage in the other.

If we first consider the case of taking off the water we find it brings out a marked divergence as between the single-step and the two-step types. The two-step endeavours to adhere rigidly to a certain angle of attack on the water and even at considerable speed there is not sufficient air control to regulate this angle through a very large range. With the single-step the machine is not stable on the water fore and aft when hydroplaning and all the control must come from the air surfaces, but a very large range of control is available and can be used by the pilot to ride over a rough sea which the two-step type, either boat or float, tends to plunge into.

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* The diagrams are reproduced at the end of the book.

In this connection it is interesting to compare for the twin-float type the difference in behaviour between the single step-type of float and the two-step or alternatively the long type of float naturally stable on the water, examples of which are shown in fig. 12.

Take the case of the single-step type with no buoyancy aft of the step and with the tail end of the machine supported on a quite heavily loaded tail float, the pilot when hydroplaning has the maximum control of the angle of the machine immediately the tail float is lifted clear of the water and the machine is poised upon the area immediately in advance of its single step (Fig. 4). There is not even a buoyancy chamber aft as with the intermediate type to interfere with this control. Obviously this type of machine is easy to manipulate over a swell by use of the air controls.

Now considering the type with long floats, the machine will endeavour to maintain its own angle and there is a strong tendency to plunge into an advancing sea (Fig. 4). The advantage is obviously with the single-step type.

But when we consider the reverse case when the engine has stopped and the machine is assumed to be adrift with the sea anchor out and is head on to the sea and drifting astern, it is obvious that the heavy loads imposed on the tail float apply serious stresses to the fuselage at or about the region of the pilot's seat with consequent risk of break up and loss of the machine, and these loads are accentuated by the wind load on the wings which are presented at a considerable angle of attack. In the case of the long float, however, the machine rides on the water without involving any stress on the fuselage other than that due to weight and the wings are presented to the wind at a lower angle of attach. We have here two opposite cases of seaworthiness in which one type or the other gets the advantage according to the conditions.

In the intermediate type an attempt has been made to compromise between these two and obtain, as far as possible, the advantages of both.

When landing on the water the conditions again favour the single-step type as the angular range of movement available can be used by the pilot to make a landing in the best attitude possible and there is no risk of a sea striking the stern of the float so far aft as to cause an upsetting couple throwing the machine over forwards. The same comparison could be made between boats of the single—and two-step types—but the difference here is not so marked.

Another important condition for seaworthiness is that of turning across wind. Under these conditions a large upsetting couple is applied to the wings tending to tilt the machine over sidewards. This is a maximum at about 45° to the fore-and-aft line of the machine and necessitates in the boat or single-float types the use of very large wing floats—a point which gives to the twin-float a considerable advantage.

Other seaworthiness conditions are largely structural and at variance with the structure weight. Large reserve buoyancy in hull and wing tip floats will give greater safety at the price of increased weight and head resistance, and naturally the stronger a float is built and the more bulkheads are included the heavier it must be.

Similarly light fabric covered wings cannot possibly withstand the force of the water when conditions are rough enough for seas to break over them and it is a difficult matter in the boat type to give the lower wing sufficient clearance in this respect. Fabric covered tail planes and elevators are easily damaged for the same reason.

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Undoubtedly the ideal wing would be planked all over and strong enough for a man to walk over. Here there are great possibilities in the cantilever form of wing construction wherein the skin is stressed as part of the structure.

Seaworthiness is largely a matter of size in seaplanes as in ships, and seaplanes cannot reasonably be expected to be any better than their equivalent size in boats and yet flying boats have been successfully handled in a sea which motor boats of equal displacement could not negotiate. In large sizes the improved structure weight of seaplanes will give an available margin of weight to be used for their improvement in seaworthiness and local strength.

The conditions of taxying or handling at slow speed in relatively smooth water present very little difficulty by the use of suitable water rudder inter-geared with the air rudder. Machines can be handled at low speeds with ease and can be navigated with the same facility as a motor boat. Some types have shown this same navigable quality without the use of water rudders at all. In coming up to an anchorage and for ease in picking up a mooring the advantage is greatly with the boat type which can be handled in a similar manner to a motor boat. With the twin-float special mooring gear has to be arranged whereby the machine can over-run the mooring which has to be picked up from the rear cockpits, but in coming ashore the twin-float is superior as it can be driven direct on to the slipway under its own power, the flat bottoms of the floats and absence of the keel enabling this to be done without risk of damage.

When used from rivers or lakes of small size many of these seaworthiness conditions do not have to be studied, and the corresponding saving in structure weight can be used to the advantage of the machine in load carried or performance, which is also desirable from the point of view of quick take-off with a view to clearing trees or obstacles on the banks.

Handling.

The present methods of handling seaplanes, in launching and bringing them ashore, can be described as deplorable, and are the chief obstruction to their greater use; until these methods are improved they must be a bar to the commercial use of seaplanes except in certain special cases.

I refer to the use of inclined slipways and beach axles. The machine is brought up to the slipway and a special beach axle shaped to the bottom of the hull is attached in position underneath it by men in waders. The machine is then hauled ashore by winches or manpower. The reverse operation is used in launching and the machine is retained on the beach axle for the purpose of handling on land.

For small or large machines the method has hardly been improved in ten years, and the resulting damage to machines and the expense of operation accounts not only for the unpopularity of seaplanes for certain operations but also for the nearly prohibitive cost.

Many improvements have been suggested, some highly practicable. Possibly the discussion will bring out some further suggestions.

For small machines in sheltered water the tidal slipway designed by Mr. Oswald Short is one of the best and most practicable methods. In this, a pier extends out into the river or harbour and attached to its end is a floating pontoon of such size that when a seaplane is alongside and broadside on, the wing tip clears the pier. The pontoon is anchored to the pier but arranged to rise or fall with the tide. A

large crane with sufficient throw on the arm launches the machine in the water clear of the slipway so that it can be brought up in any state of the tide for loading or unloading without the use of waders or undue amount of labour.

One of the greatest advantages of the amphibian also lies in the fact that it can be taxied under its own power up or down the slipways and so overcomes the principal difficulty with the ordinary seaplane.

In view of the fact that for pure seaplane purposes the amphibian has certain disadvantages as to weight and head resistance, it would seem possible for ordinary seaplanes to mount small wheels in the floats themselves, of insufficient size to cause serious resistance in the water, to be used in place of the beach axle. These wheels, which would not be large enough to enable the machine to be used as a true amphibian, would give all its advantages in this respect but without the corresponding disadvantage of increased weight or water resistance.

Another very practical suggestion, also due to Mr. Short, is that of the floating shed, which is mounted on pontoons and has a hinged slipway projecting into the water. The machine is taxied on to the slipway, which can be lifted by compressed air. Similar sheds, in which the machine is floated direct under cover are also possible.

For large machines with proper anchorage there is no necessity for bringing them ashore after every flight, but as such machines are preferably housed under cover it would be a great advantage for stations to be constructed with canals leading right into the sheds, in place of roads, and a system of lochs for bringing the machines in. To give access to the hull below the water-line, it would be possible to arrange for the pumping out of the basins inside the shed so that the machine could be settled down on to properly shaped stocks. This would have the advantage that the process of getting the hull supported would be done when the machine was not exposed to the wind. The original cost of such a station would be repaid by the decreased amount of damage to hulls when handled by present methods. A good step in this direction is the Admiralty experimental floating dock now under test. A further experiment is being carried out with a beach trolley for larger machines fitted with floats controlled by compressed air and arranged to be submerged under the machine.

Although in some situations seaplanes can be moored for long periods, and are best operated from moorings, it is essential that such a mooring should be extremely strong. No anchor of sufficient weight can be carried on the machine itself since mooring a fully-rigged seaplane is analogous to mooring a yacht with the sails set, and there is the further objection that considerable water soakage takes place and materially increases the weight of the hull. With improved float construction, and possibly with the use of metal hulls, it is possible this objection will be overcome.

The handling of seaplanes on the water, both as to alighting and taking off, presents special problems to the pilot. The aeroplane pilot has one landing problem alone—sufficient room and knowledge of wind direction. The seaplane pilot when landing head to wind may be dead across a tide of 8 or 10 knots, equivalent to landing with considerable drift. It is a remarkable fact that experienced seaplane pilots appear to be able to see the tide even in unknown harbours, and to make a correct landing, splitting the difference between wind and water speed.

In turning on the water across a wind many seaplanes have characteristic qualities and their particular good or bad features. The torque

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of the propeller has a considerable influence on the amount of rudder required. Similarly, when taking off and launching the pilot must have exact knowledge of the peculiarities of the type. It is a characteristic of twin-float machines for the propeller torque to tend to dig one float under water, increasing the resistance and causing the machine to swerve. Most machines have a preference for turning in one direction only. Others, owing to the disposition of the fin surfaces are extremely difficult to turn out of the wind.

Many of the problems of operating seaplanes concern the organisation and accommodation of stations rather than the machines themselves, and this aspect of the question has been much neglected. Also, it must be observed that seaplanes could be much improved in seaworthiness and handling qualities if data from practical experience were available to designers, and this can only come with development under working conditions.

PROBLEMS OF DESIGN.

It is, of course, impossible, in the scope of a single paper, to deal with even a small fraction of the problems in seaplane design, since such questions as hull and wing construction, stability in the air or water, water resistance, &c., could not be more than adequately dealt with if a separate paper were devoted to each subject. The writer only proposes to touch on one or two outstanding points which most affect the comparison with the aeroplane.

Water resistance.

The principal features that affect the design of seaplanes as compared with aeroplanes are, the water resistance of the hull or floats, which, in addition to imposing limits on the surface and power loading, have considerable effect on the propeller design, and the influence that type, arrangement, and dimensions have on the structure weight. Each type of seaplane has its special problems in stability, control and strength of structure.

Much research on the characteristic behaviour of various types of float and hull forms has been done by Mr. G. S. Baker, of the National Physical Laboratory, and it is only possible here to deal with the general case. In Fig. 3 are shown two typical power-speed curves—one for a V-bottomed boat hull, the other for a flat-bottomed float.

It is a common characteristic of all usual float or hull forms that the resistance rises rapidly with the speed to an initial maximum known as the " hump " speed after which the resistance falls more or less and as the total weight is by then partially air-borne and the propeller efficiency is improving with the speed the worst condition in taking off the water usually rises at or about this speed. Some hull shapes develop two such " humps."

The hump speed has two principal effects on the machine design. In the first case a margin of power must be provided so that the machine can pass the hump speed with a reasonable acceleration and this in itself is a limiting factor as to the total weight per h.p. to be carried. Secondly, it affects the propeller design owing to the necessity for obtaining considerable thrust at low forward speeds with correspondingly bad effect on the top speed of the machine.

Assuming that machine and propeller are designed for taking off on smooth water in a flat calm it will be satisfactory under most average conditions. Conditions likely to prevent the machine leaving

the water are either rough water or the case mentioned before of a smooth swell in a flat calm.

The two cases taken in Fig. 3 are roughly characteristic, but it will be noted the case of a flying boat hull has been chosen which develops two distincts humps.

With early seaplanes the hump speed curve projected through that of the power available in nearly every case and I have found in practice that a machine whose hump speed curve projects shortly and sharply through the power available will give little or no trouble in taking off, although theoretically it cannot leave the water at all. On the other hand a machine whose power required clings closely to but does not necessarily project through the power available curve is much more difficult in operation. It would appear to be a question of acceleration rather than actual power. In the first case the machine passes through the hump speed with a momentum acquired by early acceleration and in the second case the machine is unable to accelerate sufficiently to realise this condition.

This feature of the water resistance is the principal one in which the designs of seaplanes are limited in comparison with that of aeroplanes, for in addition to the necessary power to overcome it, it is impossible to use the most efficient propeller from the point of view of speed, and further, in order to obtain a propeller that shall give a high thrust at low speed, it is necessary to use a larger diameter than would be the case for the land machine propeller. This again re-acts on the machine by increased weight of chassis to give the required clearance, and the large propeller diameter decreases the seaworthiness of the machine.

In one respect the large diameter and low pitch of the propeller are no disadvantage, and as will be noted from the curves it results in an improved climb after the machine has left the water.

This question could be dealt with in two ways—one by the variable pitch propeller on which much experiment is now taking place. Given control on the pitch very much improved results could be obtained and greater loads lifted for a given power. An alternative, and seemingly easier solution, would be the provision of a two-speed gear on the engine, the gear ratios being arranged so as to give maximum engine revolutions under two conditions, (i) at hump speed for the machine, (ii) at maximum or cruising speed according to which was desired.

This is a course I have been advocating for some time and I would take this opportunity to impress upon engine designers the urgent need of this feature for seaplane work. It would seem that an engine fitted with an epicyclic gear would be particularly adaptable for this purpose as it would avoid the necessity of a clutch or gear-changing mechanism. The alternative gear could be engaged by means of a brake-band exactly in the manner of a Ford car and the only necessary operation by the pilot would be to hold in a low gear until the machine had passed the hump speed.

Comparison with the Aeroplane.

The comparison of performances of seaplane and aeroplane is bound up in the question of structure weight and accordingly I have endeavoured by plotting the actual weights of existing machines to show the great advantage that the seaplane possesses in large sizes in this respect.

Referring to Fig. 5 where are plotted the structure weight percentage on a basis of overall size for the flying boat, twin-float, seaplane and the aeroplane, some explanation of each of these curves is necessary.

Mr. Fairey.

I would mention that all three curves were plotted by taking actual figures from existing machines and that of the flying boat was the most uniform, practically every example approaching very closely to the curve. With aeroplanes there was considerable divergence, but the worst curve in this respect was the twin-float seaplane, but it should, of course, be remembered that outstanding examples of good design come well under the curves in all classes.

It will be realised that it was necessary to take a general average curve for each class of machine and by taking a high or low standard for any type the results and position of "cross over" points of the curves would be modified but the characteristics would remain.

The curves appear to illustrate the writer's suggestion that the average of advantage lies with the float type for small machines and the boat for big ones, and further, that large flying boats should be superior in performance to large aeroplanes, while large float types show enough promise to justify experiment with them.

The aeroplane curve as might be expected drops slightly for a slight increase in size and then shows a reasonable upward trend. The twin-float seaplane starting at great disadvantage to the aeroplane, which is not surprising considering the great weight of floats when applied to machines of the single-seater scout class, approaches the aeroplane curve, owing to its increasing advantage due to the lower proportionate weight of large floats and then stops short of both the other curves for the reason that there are no large twin-float examples from which to take information, and these curves are plotted not on any theoretical basis but on actual results obtained. It would appear that the float seaplane is gaining on the aeroplane in this respect.

The most striking curve is that of the flying boat. This, starting at a very great disadvantage to the aeroplane, overhauls it in medium sizes and passes it in large sizes, and in the biggest machine yet built shows even further improvement with no sign of the curve turning up. In other words the limit for big seaplanes is far from reached whereas that of aeroplanes, while not necessarily in view, will obviously be met first. Moreover, it would appear that the bigger aeroplanes get the greater will be the difficulty in handling. (One large German giant machine has no less than 18 wheels for its support). Big aeroplanes need unduly large aerodromes which must have a hard surface, and most flat country suitable for aerodromes is of a soft nature, whereas the large flying boat has an unlimited "aerodrome." It does not need the rate of climb for safety in taking off that an aeroplane does and does not present the same difficulties in handling.

It will be noted that the flying boat curve so far from increasing with the size, and although plotted from the weight of existing machines, indicated that even larger machines could be built provided the necessary engines were available. By natural laws this curve must ultimately turn up again, but it does show that the limit of size in boat seaplanes is far from reached, and in fact is out of sight.

On the theoretical basis alone there are many reasons why the overall size of both aeroplanes and seaplanes is strictly limited, but the practical results obtained appear to indicate that the limiting size is very much larger than would be anticipated from theoretical conditions. Also it must be remembered that in none of these curves are safety factors taken into account, but since many types are taken this would average out to a certain extent, and since the larger

machine by its steadier flight and the fact that there is no need to design it to the strength of the fighting scout, has a natural advantage in this respect, it is only fair that this should be taken account of in considering the average effect.

Also it should be explained that the N.4 " Atlanta " machine was not designed on the ordinary methods, but in order to keep the structure weight down special full-scale strength tests were made of every loaded member, and the members if over strength reduced to the exact factor. Since by all ordinary methods of calculating the strength of structures a certain amount of margin goes in with every assumption made, every aeroplane has a sort of hidden reserve of strength represented by this margin. In the N.4 this margin was absorbed and the corresponding saving taken advantage of. Nevertheless it should be noted that the Felixstowe Fury design approached very nearly and falls on the curve so that the advantage gained by the special methods used for the N.4 would appear to have no serious effect on the curve.

In short, the curves would appear to show (subject to any criticisms that may be made of the basis on which they are plotted) the outstanding advantages that the seaplane possesses over the aeroplane in large sizes; it is not limited by the size of aerodromes or the necessity of clearing obstacles after leaving the ground; it cannot be bogged as large aeroplanes will be if used on anything but the hardest aerodromes. While inferior to the aeroplane in small sizes the seaplane would appear to have overwhelming advantages in large sizes if these are properly developed.

Turning again to the comparison of performances, a similar curve to that of fig. 3 has been plotted (fig. 7) on the basis of a useful load of 9,000 lbs. and machines of approximately four times the size of the curve shown in fig. 3. Here, as examination of the curves will show, the advantage in performance even at top speed has gone to the flying boat, and the power required curve is less throughout the scale than for the equivalent aeroplane, practically reversing the conditions to those when the comparison is made on the basis of the small machine.

One other theoretical consideration should be mentioned in view of the fact that the seaplane, unless for use on inland rivers, is not limited by the size of the aerodrome. It would appear at first sight that some advantage could be taken of this fact with a view to increasing the wing loading with corresponding effect on the landing speed. Unfortunately for small machines, this is not the case. Landing speeds of 45 knots or thereabouts appear to be the practical limit, partly because a running landing is not always possible and the machine must have a landing speed at least low enough to make a semi-stalled pancake landing, but also because the high wing loadings would result in raising the power required curve at low speeds since proportionately less of the total weight would be taken on the wings and the old difficulty of the hump speed would be exaggerated. In this respect, however, it is suggested it is not that the landing speed of the seaplane is too slow, but that of the aeroplane much too high, and that for equivalent landing speeds the seaplane is in reality much the safer of the two.

In large machines it is possible that some advantage can be taken in regard to the loading, but that remains to be tested on full scale.

Mr. Fairey.

Conclusion.

In conclusion, I had hoped to be able to deal with some commercial aspects of the seaplane particularly in regard to its future possibilities, but I have found that, even to deal in outline with a few outstanding practical and theoretical problems has already absorbed the available time and provided more subjects than can be usefully dealt with in discussion. I can only hope that this matter will be dealt with at some future Conference or possibly in discussion, for it is important that the commerical possibilities of the seaplane should be appreciated by the general public as well as those immediately concerned with the problem.

There is one other important aspect of the seaplane question to which I would like to refer. There is an idea growing common, with some justification when judged by the merits of existing machines, that British designs lead the world. There is enough truth in such a statement in relation to the structure and performance of British machines to make it dangerous to future progress. Design and construction of experimental machines is only a part of the problem. Principles can be established by research and the arrangement and construction of machines more or less perfected in a few examples of machines, but before seaplanes or aeroplanes become practical propositons, whether for naval, military or commercial purposes, they need a long stage of development. Only practical experience of conditions in operation will provide the designers of the country with data on which to improve still further all classes of machine and there is not nearly enough information of this kind available. This case applies more particularly to seaplanes than to aeroplane design. Questions of seaworthiness, handling, etc., can only be solved by full-scale experiment. Even after 10 years of seaplane flying there has as yet been no proper comparison ever made of the relative seaworthiness qualities of various types. Such questions as landing and handling in rough seas are still largely a matter of speculation. A great step in this direction has been made by the recent formation of the Development Squadron of the Royal Air Force and this scheme should provide exactly what is wanted by the designers if carried out on a sufficient scale.

It must be remembered that during the rapid development of the War years the seaplane benefited constructionally by the harder conditions it was obliged to face. To a certain extent it may be said that the aeroplane was improved by enlarging and rolling the surface of the aerodromes. The seaplane having sea conditions to face naturally evolved as a sturdier structure, and these harder conditions account in part for its greater structure weight, but it has now reached a stage when designers are definitely awaiting data. They need experience of the large types already built before proceeding to still larger ones.

With reduced structure weights and larger machines the range will be greatly increased, and although by flying overland the commercial aeroplanes may shortly reach India and Australia, if communications are to be established throughout the Empire without crossing foreign territory, this work will have to be done by seaplanes, and with proper development, I suggest that they are the most promising apparatus for the purpose.

The CHAIRMAN: Your Grace, my Lords and gentlemen, it will be agreed, I am sure, that we have heard three very instructive and excellent papers. The last one seems to be full of matter for discussion to-morrow. Before we part I am sure you would like to express your approval of those papers and your thanks to the authors for the great amount of trouble they have taken and for the pleasure they have given us in listening to them this afternoon.

SECOND DAY. WEDNESDAY, 7th FEBRUARY.

MORNING SESSION.

His Grace the DUKE OF SUTHERLAND, UNDER SECRETARY OF STATE FOR AIR, in the Chair.

The CHAIRMAN: My Lords and Gentlemen,—The papers that we all listened to yesterday were, I think, of such extraordinary interest that even one who, like myself, is not a technical expert appreciated them thoroughly. All the same, I felt that it was unfortunate that the time at our disposal for finishing that last most interesting paper on Seaplanes which was read by Mr. Fairey, was cut short. Personally, I cannot help feeling that it would be a good thing another year to extend the Air Conference from a period of two days to one of three, or even four days, if those who attend the Conference are in favour of that idea. The Air Conference is, after all, a very important one; I might almost say that it is the Parliament of the Air, and I feel that the fullest time should be given both for reading and discussing those subjects which are of the greatest importance to the future of aviation and the aircraft industry. It is possible that all who were here yesterday and are here to-day would not, for business reasons, be able to remain the whole of the time. On the other hand, those who are specially interested in any particular subject would be able to go into it more thoroughly and with less haste than is necessary under the present arangements.

I was very relieved to see yesterday in the *Morning Post* above Lord Gorell's signature, that whatever happened to-day I should not be held responsible for any blame. I was very relieved to see that he had taken the full responsibility on his own shoulders. I hope that no blame is imputed in any case, and I do not think that anything has gone wrong up to date; still, it was with a great feeling of relief that I saw this. I am afraid that next year, if I am still here, I shall not have that nice feeling that somebody else is partially responsible.

There is very little left for me to say to-day. I think the Secretary of State and the Director of Civil Aviation yesterday touched on every important point that concerns both military and civil aviation. I propose, however, to make one or two very brief remarks at the end of to-day's Session in reply to any suggestions or speeches that are made during the discussion this morning, and I shall also call on the Director of Civil Aviation to reply to any criticisms of a technical nature that are made this morning and which he feels inclined to reply to at such short notice. I shall also ask Sir Geoffrey Salmond to do the same thing this afternoon in regard to any questions that are raised on his paper, that he is disposed to answer at such short notice. The Secretary of State said yesterday, I think, all that can be said at the present moment on the question of future policy, both as regards civil and military aviation, and I think you can rest assured that you will be informed directly the lines of future policy in regard to these great problems have been settled by the Cabinet. In the meantime, I can assure you that the discussions and papers of yesterday and to-day will receive the deep and interested attention of the Air Ministry, and I believe that much real good to air interests, both public and private, will result from this Conference and from other assistance that we are getting from civil experts.

Nor do I think it will be found, when the time comes, that we are wasting the time of the experts, either here at the Air Conference or as members of the Civil Aviation Advisory Board—those experts who take the trouble to give both those interested in aviation and the Air Ministry useful information on these very important subjects. On the contrary, when the time is ripe something really substantial and business-like will, I am sure, emerge which will, I hope and believe, in view of our present financial difficulties, satisfy the aspirations of even some of the most enthusiastic in the ranks of civil aviation. I have always thought that the great thing in this world is to expect the worst and then, very often, one is agreeably surprised; in any case one cannot be disappointed. I think that is, perhaps, the attitude of many of you. I feel that we must keep in mind this point, that however keen we may be to encourage schemes that cost money in the interest of civil aviation, we must always remember that for every one of us who is keen on civil aviation there are many thousands in this country who think the Government are both wicked and extravagant if they are not in a position, by means of economies in every direction considerably to reduce taxation each year, We have to keep that in mind; perhaps we sometimes feel that way ourselves; but none the less we fully realise that aviation—that great new force—has one of the strongest claims for consideration by the Government amongst those things which may be said to have a claim.

We look forward, therefore, hopefully to a sympathetic policy being laid down and to a great future for that great industry. Before calling on the speakers to-day I should like to read a telegram from the late Under Secretary for Air who preceded Lord Gorell in office, the Marquess of Londonderry, who telegraphs to say:—"I very much regret that I am unable to be present to-day. I wish the Conference every success."

I now have much pleasure in calling on **Mr. Holt Thomas to offer some remarks on** yesterday morning's papers.

Mr. G. Holt Thomas: Mr. Chairman and Gentlemen, your Grace has been kind enough to use the word "criticise" in inviting us to speak this morning, and I hope that you will take any criticism I have to make in quite a friendly way. It would be quite impossible, I think, to criticise the new administration in any way, and it would be grossly unfair to do so at this stage. In reference to the opening remarks, I think the Air Ministry can take it, from various things that one sees and hears, that the country will be thoroughly at the back of the Ministry in any advancement of aviation, and the City of London has certainly shown itself to be so in my experience.

Perhaps I might allude to Commander Dennis Burney's paper first. Commander Burney, I know, is under the impression, or has been, that I am against his airship scheme. That is not the case at all. I cannot see how the Navy can do without airships. The only question, as he frankly admitted himself, is as to whether the problem is best attacked from the commercial side. We have no data such as we have in reference to aeroplanes to show what an airship service costs per ton-mile; especially have we no data to show at what speed—and it is speed which is the sole value of civil aviation—the airship would travel against ordinary normal winds. I do not want to see the aeroplane, which is a practical proposition, as you know, robbed of any funds available, but I am all in favour of any scheme which will bring along airships.

As regards General Brancker's paper, I think we must congratulate him upon it, especially on showing the improvements that have been made during the past year in wireless and things of that sort on which the future of civil aviation must depend. I trust, however, that this Conference will not become simply a record of the past, but that it will deal with the future. Sir Samuel Hoare said yesterday that he stood in the midst of experts and felt rather diffident about speaking to them; but this Air Parliament—as you, sir, have rightly called it—was not meant to be a committee of experts. It was meant to be a meeting of business men of London who would take a great interest in the subject. At the first Conference, when Mr. Churchill was in the Chair, I put it to him that this Conference would not do very much good unless it passed resolutions to which the Cabinet would pay some attention, and perhaps I may be allowed to move my hardy annual when I have finished my remarks.

With the exception of indicating most of the practical steps which have been taken up to date during his *régime*, and referring to the question of subsidies and improvements in wireless, General Brancker had nothing very much to report. The proceedings were opened yesterday by the Lord Mayor. He is the third Lord Mayor who has spoken of the great interest taken by the City of London in this subject and this, if I may say so, is the third Air administration that has been represented in the Chair and has expressed pious hopes. Admitting the political difficulties, they do not prevent us having an air policy which can be carried out when those political difficulties are over. We know a very great deal now about aeroplanes. Everyone in this room knows exactly what an aeroplane can do, after three years of the London–Paris service. Everyone knows that flying from London to Australia in so many days, and from London to India in so many days is only a question of money. The first thing, in my mind, is to consider a point to which General Brancker did not allude to any extent, namely, what will civil aviation really do for British industry; is it any good or is it not?

At the present moment we are paying a good deal of attention to passengers, in my opinion quite wrongly. As General Brancker knows better than anyone else, my opinion has always been that we must not depend on passengers. The passenger traffic will be affected, as he says in his paper, by accidents and so on. I think that we really should see to what use we can put this form of transport which has become a thoroughly practical one. Assuming that my criticisms will be taken in the right way, I will say that I am a little disappointed with the map* which appears behind you, sir. General Brancker knows that the map issued three years ago would show routes which are now in existence and ought to have been under British auspices. Some of them are gone. That is the same map, if I may say so, as that which I showed at the Central Hall to an audience of 3,000 people, composed very largely of business men, six years ago. I was a little disappointed also by General Brancker's remarks as to London–Paris being not much good; because when I started it I regarded it as the first step with any value in it to the Empire. Off to the right hand side of the map lie the routes to the British Empire, and it seems to me that the policy of this meeting and of the Air Ministry ought to be to resume as soon as we can those routes in that great field that lies before us.

General Williamson may have something to say with regard to the remarks I am now going to make. The United States of America, in my opinion, have taken the practical course. It was quite evident to them that air transport was the fastest form of transport in the world, and they asked themselves whether it was of any use to them. Without any further examination, they simply proceeded to start an air service. There are, I know, people who say: "We must look at these figures with care." At the same time, I have had the privilege of seeing the figures time after time in the form of official blue prints which give all the records. Those figures, as a matter of fact, correspond very closely with those given us by General Brancker yesterday. Whatever those services from New York to Chicago and San Francisco are doing, it is quite certain they will never stop. They will be improved, and then a night service

* The map referred to was one showing European air routes, to illustrate General Brancker's paper, and is not reproduced.

will be started as well. That, in my opinion, is taking a real practical view of civil aviation.

We, on the other hand, have not considered of what use civil aviation will be to us or to the business of the British Empire. It seems to me, with the facilities which the United States already has between New York and San Francisco in the way of fast railways and so on, that we could not possibly compare the utility of those services with the utility of those between London and the greater outlying parts of the British Empire, on which our trade very largely depended before the war and on which it must more largely depend now. I think the London–Paris service is of great use simply because it accomplishes that which no other form of transport can ever hope to do. As an instance, supposing we wished to send General Brancker's paper to Paris to-day, within the four hours he mentioned, how should we be able to do it save by aeroplane? If it were sent by wire it would get there very little more quickly, if at all, and at $2\frac{1}{2}d.$ a word, the cost would be 500*l.* My view has always been that there are in London and Paris enough people who would employ the London–Paris service, if only that service was put before them in a proper way. I have found it possible to do by means of the London–Paris service many things which were impossible in any other way.

Again, taking General Brancker's paper as an instance, if you wanted to send it a little further afield, to Australia say—I am taking the licence of a critic in not sending it by code—cabling would cost 7,500*l.*, or 3,750*l.* at deferred rate. If it was sent only as far as India, the cost would be 4,000*l.* by the full rate or 2,000*l.* at deferred rate. That is a silly instance, you will say, but there must be hundreds of firms in Australia and India who would take advantage of such a means of transport. You must remember that in the course of this journey from the terminal point of departure the aeroplane passes through a tremendous lot of places. A service to India will also serve Ceylon, while the service to Australia will serve New Zealand, Hong-Kong, the Malay States and heaps of other places. I have seen hundreds of tons of mail unloaded at Port Said for distribution on the other side of the Suez Canal. Those are things which the City of London—whose representatives, it seems to me, ought to be here—should bear in mind in considering the services that civil aviation can really render. As I have said, if General Brancker's speech were sent to Australia by aeroplane and charged the same as if sent by cable, the charge would be about 7,500*l.*, which for 10,000 miles would roughly work out at 15*s.* a mile.

In reference to the Civil Aviation Advisory Board which came about, I think, as the result of my resolution in favour of an Imperial Air Service, the first thing that Board was asked to consider was the service to Baghdad. In considering the first thing the Air Minister put before that Board, I do not think it would be judicious to say that it was not a very suitable subject for them to consider; but from the practical point of view it is something like considering a service to the Ascot Races which started halfway down, left London out and arrived ten miles from the racecourse. There could not be a more unsuitable place to consider than Baghdad; at any rate, it meant that we were considering a very difficult portion of the route and leaving out the great saving in time which would result if the service started from London by air and went straight through. The route to Baghdad is simply an intermediate stretch of what is undoubtedly difficult country.

One other thing that impresses me is this, Sir Samuel Hoare said yesterday that one of our difficulties was the great shortage of money; in saying anything to Sir Samuel about finance, one naturally feels diffident, but that is not my experience. I make that remark simply because in 1921 this very City of London agreed in twenty-four hours to put up 1,000,000*l.* for the cross-Channel service. The first subscriber was one of the biggest bankers in the City, and, as I say, in twenty-four hours that sum was underwritten without any remuneration to the underwriting houses. All the subscribers were bankers and financiers. I am not suggesting that the money was put up in the least with the object of making a large profit. It was put up to support a national ideal. I was glad to hear Sir Samuel express the desire for an imperial air service to be started as soon as possible, and I am perfectly certain that if the British Government lays down its policy in that regard it will have the country behind it, and that the money would be found in five minutes. If it was really for a national or imperial purpose, my own idea is that the money which would have to be found by the mother country would be a very small sum per annum, because every one of the overseas dominions is perfectly willing, I believe, to help in a great service which would traverse the Empire from one end to the other. Referring to the cross-Channel services for the moment, I would like to see the operating companies coming together and forming a really important corporation. I cannot speak for them; but I think the Air Ministry would not attempt to stop it because of the importance of air transport as compared with any other form of transport, having regard to international agreements. The sea, for instance, is mostly outside the three-mile limit, and vessels call at certain ports. But an air service, as General Brancker said yesterday, is not only going to fly over other people's countries, but to fly to and land in the heart of them, with the result that there must be a great many international agreements made.

General Brancker said yesterday, in his paper, and Sir Samuel Hoare emphasised the fact, I think, that anything that was done would be much better done by commercial interests without much interference from the Government. It seems to me, at the present moment, at any rate, that the inauguration of British air services will be carried out by two sets of people: firstly, by the Government of Great Britain itself, as a member of the International Air Convention—a Government convention—and secondly—and this seems to me to be absolutely necessary—

by the commercial companies themselves, through whom the Government will act; they, too, must have agreements. With a British air line, it seems to me that you want a great national or imperial corporation, working hand in hand with the Government, in order that the agreements made with what are practically national companies in almost every country should be on the same lines.

In conclusion, may I express the hope that your Grace will be an exception to the previous holders of your office and will preside here next year. I also hope that this Conference will not only give us a record of the past but a forecast as to the future. Resolutions coming from this meeting should, I think, be taken notice of by the Cabinet, and I hope that the meeting next year will be held in the Guildhall, instead of in the Council Chamber, with the representatives of the City of London and of every industry here, and that it will pass resolutions of which the Cabinet will really take serious notice. The resolution I wish to propose is in the following terms :—

> "That in view of the necessity of increased rapidity of communication within the Empire and in view of the progress made by other nations in civil aviation, this Conference calls upon the Government to give due and immediate consideration to the foundation of an air mail throughout the Empire."

I will ask Admiral Mark Kerr to be kind enough to second that resolution.

Admiral Mark Kerr, C.B., M.V.O. : My Lord Duke, My Lords, and Gentlemen, In seconding this resolution I wish to add one word to what Mr. Holt Thomas said a short time ago about the traffic. He said that he did not believe in the passengers. Three years ago I was made chairman of a United States Committee, and, with the exception of the Chairman, you could not have got a better one together. There was the Vice-President of the American Express Company, there was Edison's head man for, I think, twenty-five years, and there were two distinguished business men who were very rich. There was also—possibly everybody will know him —the best technical officer in the Royal Air Force, Colonel Stedman. That Committee went into the matter of starting a service of aeroplanes from New York to Chicago and back. The only thing I laid down, to begin with, was that it should be a freight-carrying service until it paid, because passengers pay in no form of transport in the world, except motor-cars; freight is the thing that pays and passengers are the thing that advertise. The Committee went into the question and found out that I was correct, and that by carrying light valuable freight —187 trains full of all kinds of freight leave New York every day—there would be sufficient to run several 'planes every day to all the great cities in America. Allowing for every mortal thing, the making of the aerodromes and so forth, and dividing the final profits by four, the profit came to over 100 per cent. from carrying light valuable freight and money and securities. On money alone, the moment you can beat the trains you save a day's interest, or two days' interest, and, in crossing the Continent, several days' interest; and that not only on money sent but on the return vouchers.

In England, I was asked to become a director of one of the air companies which were started, but I said that unless they would start with freight I would have nothing to do with them; after the freight paid, they could then go to passengers. That is intimately connected with the resolution here, because if the Government will take up and start these routes for carrying mails, mails will pay in themselves, after they have been working for a certain time and the first charges have been cleared off. If the Government did that, it would give the greatest encouragement to other companies to run with freight. Freight, as I have said, will pay wherever you can beat the train, and across the Continent, where a great deal of money and securities go, it certainly will pay.

I have great pleasure in seconding this resolution, and I hope that one day the Government will stir up and do this.

The Chairman : We have listened with much interest to the speech of Mr. Holt Thomas and the speech of Admiral Mark Kerr. They have proposed and seconded a resolution which I have much pleasure in putting to the meeting.

On a show of hands.

The Chairman : That is carried almost unanimously, I think.

Lord Gorell, C.B.E., M.C. : Your Grace and Gentlemen, I feel that it might be desirable for me to intervene for just a few moments this morning as it fell to me to be responsible, to some extent, for civil aviation for about nine out of the twelve months under review. As I took up a considerable amount of your time last year, I do not propose to do so this morning, but I would like to say a word about the speeches which were delivered and the papers which were read yesterday morning. It might be convenient if I took them in the reverse order, and began with Commander Burney's paper on "The establishment of a self-supporting airship service." I think it might more profitably have been given the title of "A disquisition into the supremacy of aircraft over seacraft." I doubt very much whether anybody who has interest in, knowledge of, and sympathy with, the Navy could have made so bold as to state the case for the supremacy of aircraft so succinctly, without running the risk of being adjudged prejudiced too greatly in favour of aircraft. We have never had it stated quite so definitely that sixteen airships could be produced for the cost of one battleship, nor that nine airships could do the work of sixty cruisers, and thereby save a cost of 51,750,000*l.*; or, in other figures, that per square mile of reconnaissance airships would do for 1*l.* 5*s.* what it would cost 77*l.* for the cruisers to do. Those are very valuable figures, and all who are really believers in the

Mr. Holt Thomas.

air must welcome the fact that anybody so connected with the sea as Commander Burney should have stated them so publicly.

Into the latter portion of his paper, which was the history of the Royal Navy in its early days, I do not propose to go. It did not strike me as strictly relevant to the subject of his paper, and I noticed throughout the last half of the paper that he spoke entirely of the Admiralty; in fact, the scheme which he began by discussing was submitted last August to the Admiralty. I felt at the time, and I felt again when I heard his paper, that it was rather an unusual proceeding that when, for example, you wished to take over Mr. Jones' house you should go to Mr. Smith with the proposal to do it. There was not one mention, from start to finish of his paper, of the Air Ministry. Therefore, it seemed to me a little inconsistent when I noticed that he agreed heartily with General Brancker that airships and aeroplanes could not be regarded as in any respect rivals but must be complementary one of the other. But the whole thesis of the paper was to establish that rivalry in all its old and harmful form, and much of the later pages were devoted to the question of the carrying by airships of aeroplanes. Unless it is proposed that the whole of the Royal Navy should take to the air and that all the aeroplanes also should go away from the Air Ministry, you there at once have definite rivalry and dual control again.

Therefore, it seemed to me that the inference which was drawn from the last half of the paper—that an airship scheme should be started for the benefit of the Admiralty—was not entirely a correct one, but that if the figures as to cost and as to the supremacy of aircraft over seacraft were correct, the inference should more truly be drawn that the sums now being spent between the Admiralty and the Air Service are very disproportionate. I regret that in a paper which was to deal with a self-supporting airship scheme, so much time should have been devoted to the use of the airships in a way which I can only describe as a stalking horse, under cover of which to attack the control of the air by the Air Ministry.

With a great deal of the opening pages I express myself heartily in agreement. With all that was said about the great developments in regard to the mooring mast one can most heartily associate oneself; also as to the knowledge of the endurance and capacity of airships. The question on which one feels bound to join issue is really contained in the word "self-supporting." Under the scheme which was outlined, the State would have to guarantee the interest, and I think the frank confession was made that without such State guarantee it would be impossible to obtain the necessary financial assistance. That is hardly what one would mean by the word "self-supporting." Of course, one can agree entirely that the difficulty of establishing any airship service is that you cannot make small experiments; they must be full-scale experiments, and, therefore, must be a very costly affair.

On the whole question I think very few who have gone into it at all are not wholly in favour of the establishment of an airship service; but if, as we have heard from the Secretary of State and others, and as we all know, financial considerations are extremely difficult at the present time, and there is only a limited amount of money available for aeronautical development, while those conditions remain, and while it is necessary for the State to come forward with a large guarantee, I would much prefer to see the money spent now in the development of heavier-than-air craft.

If I may now turn for one moment to General Brancker's paper, he was pleased to refer to a joke of mine about the arrow and the target. Last year he was, undoubtedly, one of the straightest flying and most surely-aimed arrows that the Air Ministry had to meet. I do not know really that he is quite so successful as a target, because he very frankly admitted that he was there to be shot at. He did give in each side of the review a definite account of a certain amount of progress, whilst admitting that more progress was hoped for. It is probable that many of us would feel sceptical as to his estimate that in five years' time civil aviation will be on a paying basis; at any rate, in several directions—in miles flown, in routes opened, and perhaps most particularly in his safety statistics—he did give a record of definite progress over last year.

He mentioned one thing that I want to question. He spoke of the temporary scheme which is now in operation under which the three companies are flying to Berlin, to Cologne and to Paris. I hope that may not be considered as in any respect a temporary scheme, except only that we have yet had no indication from the Government as to their future whole policy with regard to subsidisation; because those three routes are the three main arteries along which all air transport of the future must go. The first goes past Paris, and I would differ, therefore, from any deprecation of that Paris service, because it is the first stage on the southern route. The second route is the main direct route to Constantinople, and the third route goes eastwards to Moscow, and the whole of the Eastern possessions and Eastern countries beyond them. It is along those three arteries that development must take place over the world from England, because England is unfortunately situated in having no possibility, until trans-Atlantic flight is practicable, of going westward.

Then General Brancker mentioned several factors which he said in his view were most important from the point of view of increasing traffic, such as speed, lower fares and, above all, safety. I should like to emphasise once again two others which seem to me of supreme importance from the passenger point of view. The first is comfort, and though improvements have been made in the last year in that direction I think there is a good deal of room still for making air travel more comfortable. The second, which I think does get in the way of many ordinary people who are considering whether they should go by air or by rail and sea, is the

question of noise. I do not know yet, I am not sufficiently expert to know, how far that problem of the drone of the engines, which is really deafening to the ordinary passenger, has been tackled; but I am sure that it must be in some way mitigated before you can have a very large expansion of traffic.

I would agree entirely with what Mr. Holt Thomas said as to the undesirability of laying too much stress upon passenger traffic. I believe that to develop the air properly, concentration should rather be on the transport of goods. In that connection one of the most illuminating facts mentioned by General Brancker was, to my mind, the action of the United States Government. This is a matter which I think we ought today to hear something definite about from General Williamson. Why is it impossible for the Post Office in this country to take the same view as has been taken by the American Government with regard to sending letters by the quickest mode without surcharge to the public? Are we not now arrived at the position when we are entitled to say from the statistics that air transport has become absolutely reliable, and that it is the duty of the Post Office, without asking the sender by which means he wishes his letters and mail to go, to send the mail by the quickest route?

Then I would like to associate myself most heartily with what fell from the Secretary of State yesterday with regard to the work of the Civil Aviation Advisory Board. That was set up on the personal direction of the late Secretary of State, Captain Guest. It was his own idea, following, no doubt, upon the suggestions made at the Air Conference. I do not think that credit has ever been properly given to him for the idea. The Board has produced so far only one report; but that report, as all who have studied it recognise, involved a tremendous amount of work, and I think one ought to state here that the very greatest credit is due to two people in particular for that work—one, General Brancker, and the other, Sir Geoffrey Salmond. All the members know how hard those two gentlemen worked in getting together all the various details.

With regard to the opening remarks of the Secretary of State yesterday, I think we should all agree with Mr. Holt Thomas that it would have been unfair to expect from the Secretary of State at this early stage in his administration anything more definite than he gave us. But his remarks struck me as both helpful and hopeful. More important at this stage in his administration than decisions is the attitude of mind that he brings to bear, and the way in which he spoke of his attitude of mind towards the problems of his Ministry was most encouraging. Whether we agree with the present Government or not, I think we must agree that constant changes and Ministers coming new to a very intricate subject are to be deprecated. We have had a good many of them for one reason and another, and we may hope that in some respects, at any rate, the air is now becoming one of the subjects which may be regarded as above purely party considerations. Foreign affairs have long been elevated to that position. I suppose this is, perhaps, the first time on record that the Foreign Minister of one Government has passed into the other as Lord Curzon has done. For myself, I have long hoped that education would be regarded as above party, because on that depends the prosperity of the country. Upon foreign affairs and our relations with foreign countries depend security, and that is a condition precedent to prosperity. The same may be said of the air. Without a definite stable air policy we shall not have security. Quite apart from whatever Government may be in power, as long as there are Ministers who really recognise the dominant claims of air, they may be sure, at any rate as far as I can give it, of whole-hearted and cordial support.

Lord Gorell.

Mr. F. Handley Page, C.B.E., F.R.Ae.S. (Handley Page Transport Limited): Your Grace, my Lords and Gentlemen, Mr. Holt Thomas referred to the map which General Brancker had mentioned and seemed to indicate that at this third Air Conference we should have made a little progress. On the other side of the Chair we see a map of Australia, and at this Conference we can see that progress has been made at any rate at the other end of the Imperial air route. I hope that at the fourth Air Conference we may see between those two maps another map showing the imperial air route in actual operation. Such a map will fill the gap which at the present time the representatives of the Air Ministry supply. The routes that are shown on the map to the left mostly concern Central Europe, and it does seem, in looking at it, that those routes are built on what to a very large extent is a political volcano. If, on the other hand, developments were to take place to the south, on the southern route, we have countries with perhaps a little more stable government and the routes through them lie towards the Colonies; so that if attention were directed to that part rather than to the other parts, it would seem to have a more permanent beneficial effect on air matters for this country.

Leaving the future, it is very interesting to see the progress that has actually been made in civil aviation during the past year. It is a matter of some personal satisfaction to myself that the Handley-Page Company has during the past two years made no claims of any kind whatever against the insurance companies for accidents to machines. That leads to confidence on the part of passengers in air travel and, therefore, is one of the most important factors in civil aviation. In regard to the question of the actual type of traffic that should be sought, I am afraid I must disagree with those speakers who have said that passengers are the last thing that one requires, and also that no company has made a commercial success by carrying passengers. The greatest organisation for carrying passengers in Europe, the Compagnie Internationale des Wagons-lits, exists only by transporting passengers and feeding and sleeping them on their trains, and that company, I believe, is a great

financial success. The passenger will always pay you far more than you will get for any goods to be transported, because his time is much more valuable than any parcel or freight or traffic of any other kind which you can send by train. It would therefore appear that passenger traffic is, with the exception of mails, the traffic *par excellence* that should be looked for.

I was very pleased to hear from the Secretary of State for Air that he contemplated giving a long tenure of security for the transport companies operating on the subsidised lines. That will make it possible for private enterprise to lay down secure foundations and build for the future—a thing which is impossible at the present time, seeing that the present subsidy scheme comes to an end in March of next year. Under that scheme I hope that there will be an incentive to carry on and obtain more traffic beyond a certain amount such as we have in the present scheme. The old scheme has been described by Sir Sefton Brancker as one, according to the Biblical precept, of taking away from the man who has not in order to give to the man who has. If the Air Ministry have abandoned Biblical precept in the conduct of civil aviation and are proposing to give to civil aviation firms some material benefit in the present rather than a hope of good things in the life hereafter, I am sure it will be greatly welcomed by the civil aviation companies.

Under this new scheme I hope that, apart from the subsidisation of civil aviation routes and companies, the subject of research will not be lost sight of. The most important thing to-day is the evening up of the traffic during the summer and winter. The difficulty has been referred to as being partly due to the type of traffic which travels during the summer—namely, the tourist traffic—which is non-existent during the winter; but I hardly think that is the whole reason for the difference in the traffic. In the winter time, especially at the present time, it is impossible to get a sufficient number of machines through to carry the traffic which would offer were it of such large dimensions as in the summer; and quite apart from the tourist traffic, it is a question of not being able to fly in the winter time as compared with the summer. To get over that difficulty an operating firm must be able to carry out research, to discover whether it is possible to fly through fog, whether it is possible for the pilot to use certain instruments and so forth. That is research which can best be carried out by a company that is operating. There are many other points which are necessary to improve the operation of transport companies, and I therefore hope that in the new scheme grants for research, quite apart from subsidies to lines, will be given.

Major-General THE RT. HON. J. E. B. SEELY, C.B., C.M.G., D.S.O.: My Lord Duke, my Lords and Gentlemen, I did not know I was to be called upon now, though I came here with great pleasure, not to speak, but to listen. I rejoice that there is real progress in civil aviation. I congratulate General Brancker on his lecture, which seemed to me to be admirable both in form and substance. It is very difficult, I know, at this present moment to foster this industry as you would wish. The reasons were given by the Secretary of State. But if you cannot make great advances, if, at any rate for the moment in these difficult times, you can maintain the integral independence of the Air Ministry and the Air Service, which I regard as vital, the industry as we see it and, above all, its designing staffs and the research side, then you will have deserved well. I would go further and say that in the interests of the country as a whole it would be well worth while if we could expand in the air. No doubt, the future lies largely in the air. Everybody here agrees to that. If that be so, I doubt whether it is wise economy to starve the Air Service either on its civil or its military side. Therefore I venture to express a humble hope that you will be able to increase and not only to stand still.

If I were asked what, apart from governmental action, would most help civil aviation, I should say on the technical side—and I had proposed to say just this one word before Lord Gorell spoke—it would be the elimination of noise. I say this not from my own knowledge but from consultations I have had with various people of great scientific eminence. There is one aspect of it that is not generally appreciated. We all wish to eliminate noise for the comfort of travel, so that when we arrive at the end of our journey we may not be somewhat deafened by the noise; but I think it is often forgotten that it would be an enormous advantage to the pilot who conducts the machine if the drone of the engine could be reduced. I am told by my scientific friends that the reason for that is this. The great problem of air travel—which is a three dimensional travel—is that the brain finds it difficult to do more than a certain number of things at the same time; so that it is proved that if you give the pilot too many extra gadgets to control it is a physical impossibility for his brain simultaneously to direct itself in those various ways, and I am told that the number of things which the brain can comprehend and use at the same moment depends directly on the amount of silence in which that brain is able to work. Therefore if you could to a great extent eliminate the drone and noise of the engine you would enormously simplify the task of the pilot. I hope and believe that my scientific friends are right in not only telling me this fact, which I believe to be mathematically and physically true, but that great progress is being made in the elimination of noise and that, although it is not yet brought forth, it soon will be.

The second thing that it seems to me would be of enormous advantage to civil aviation, especially in these islands of ours, is a further advance in the problem of rising from and alighting upon water. Everyone appreciates the immense advantage of that vast natural aerodrome, the sea; but the difficulties of getting off it and the difficulties of landing on it are very familiar to all of those who have to deal with this most intricate problem. There, again, I am told, and I hope and believe it to be true, that

great advances are in prospect and that therefore we shall have considerable advances in both seaplanes and flying boats. I say again that I came here to listen and not to speak to-day, but I would re-echo the wish that has been expressed in more than one quarter that the rapid succession of Air Ministers passing through your office may somewhat slow down, and that we may have the privilege and the pleasure of seeing you, sir, and your distinguished chief, the Secretary of State for Air, in your present offices for many Air Conferences to come. May I, in sitting down, cordially congratulate all the officials of the Air Ministry on the success of the work they have been now carrying on for so long in circumstances, as I well know, of particular difficulty. I congratulate them on all their work and not least on the success of this Air Conference which they have promoted.

Mr. A. H. ASHBOLT (Agent-General for Tasmania): Your Grace, my Lords and Gentlemen, Commander Burney in his paper yesterday referred at some length to the advantages of airships for home defence. Personally, I would prefer that the question of airships should be discussed more on the imperial basis. As many of those who are present know, it was the imperial aspect and its possibilities that brought me into the fold, and I still maintain that nothing will improve imperial trade relations more than the speeding up of communications which can only be done in the air. Just consider for a moment the difficulties that have arisen only in the last few weeks in connection with the proposed Economic Conference. The political conditions in all the overseas dominions at the present moment at least show that it is practically impossible for the Prime Minister or any Cabinet Minister of high rank to get away from his duties for the length of time necessary to attend what undoubtedly will be an important conference at the present stage of the Empire's growth.

Frankly, it seems to me that we are no closer to the establishment of long distance imperial communication than we were some twelve or eighteen months ago. The only satisfaction I have is that the airships, sheds, etc., have not yet been completely broken up as was originally intended. At the same time I feel some uneasiness even in this respect because of the gradual frittering away of what I may describe as assets of the Empire—the imperial airships. The stations at King's Norton, at East Fortune and at Howden have all of them, since my original negotiations with the Government, been taken away from airships and sold and dispersed. I do hope that nothing further will be done in the direction of dispersing our airship assets until some definite decision has been arrived at with regard to the proposals which Commander Burney has now placed before the British Government. It would prejudice tremendously those proposals either now or in future, if the remaining stations were broken up and disposed of and were not available for those imperial communications which, in my opinion, are of such great importance to us all.

General Seely.

There is one thing in this connection that I cannot quite understand, and that is the delay in and the mystery over the publication of what I might call the Amery Committee's report. Rumour has it that this report is strongly in favour of the establishment of an airship service, and one can only assume that the correctness of this supposition is, perhaps, the reason for the withdrawal of the report. As the representative of one of the overseas colonies, I feel, as do several of those who are associated with me, that we have not been quite fairly treated in the withholding of what is probably a most important public document, particularly in its connection with the speeding up of communications all over the Empire. Therefore, in the interests of imperial trade and quite irrespective of the value of airships—the benefit of which Commander Burney dealt with at some length yesterday—I do urge that this report should be published without delay, so that if we who are airship enthusiasts are wrong and have been chasing a will-of-the-wisp, the sooner we know it and the sooner we are wiped out the more time there will be for devoting to heavier-than-air craft.

I agree with what was stated yesterday that the airship and the aeroplane will work naturally together and are not in any way antagonistic. Commander Burney also, in dealing with the establishment of an airship service, pointed out that it was not like any previous means of communication. Trains, steamers, motor-cars, all started in a small way, and it was a commercial possibility to start them in a small way. But with airships, even the smallest of them, a start can only be made on a very big scale and by the expenditure of a very considerable capital sum. But the claims of these long-distance services can only be proved by an attempt to carry them out. Theoretical discussions as to whether they can or cannot do all that is claimed for them are so much beating of the air. It is only by practical experiments over selected routes of an imperial kind that their utility and capacity can really be determined.

I have heard rumours in various quarters and in this room to-day of differences of opinion between the Air Ministry and the Admiralty. Such inter-Service jealousies are always detrimental, and, in my opinion, have been very detrimental to the progress of air communication between the overseas Dominions and this motherland. Is it not possible that these inter-Service jealousies should be got rid of in the interests of the nation? So far as the Air Service and the Navy are concerned, there already is an interlocking in the provision by the Navy of aircraft carriers and in the provision by the Air Ministry of aeroplanes for carriage by those naval aircraft carriers. Cannot that principle be expanded? Cannot the Navy and the Air Ministry work together on the one side for developing imperial communication and on the other for defence purposes by the association of airship carriers for aeroplanes which seem, and which I understand are admitted by nearly everyone to be

a more practical possibility and will probably be one of the big developments in the next war, when it unfortunately comes?

Gentlemen, I would like to say one more word, and that is that the big saving in naval expenditure indicated by Commander Burney yesterday and by Lord Gorell this morning would, in all probability, compensate or more than compensate for the expenditure on the development of the imperial trade routes, and I commend to His Majesty's Government with all the seriousness I can command the great desirability of giving a lead to the overseas Dominions in this respect. I also urge the early publication of the report to which I referred, which would probably clear up some of the difficulties respecting those matters which are now before us.

Sir ALAN ANDERSON, K.B.E. (representing the Chamber of Shipping): Your Grace, my Lords and Gentlemen, The Chamber of Shipping have given me no detailed instructions, indeed, no instructions at all, so I must ask you to take what I say as the view of just one ship-owner who is personally concerned in the transport of passengers, cargo and mails to the great dominion of Australia. We have all had a very bad year, and there is nothing surprising in finding that a young industry like the air industry has felt it perhaps more severely than better established ones. I do not want to say anything critical at an inconvenient moment when criticism is less needed than confidence; but there is just one point on which, I think, a critical note may be sounded with advantage.

The Secretary of State for Air told us yesterday that in the disturbed condition of the world we must all recognise that imperial needs must have precedence over commercial needs; I forget his exact words, but that is the sense of them. Now I venture to suggest that in this, as in many other things, the longest way round is the shortest way home. It has never been proved in the past that the nation which failed to take the lead in commerce was able to sustain or had the will to sustain the great armaments needed to prevail in war. I believe that the same truth is apparent in the air, and that the nation which takes the lead in air commerce will in time of war inevitably be masters of the air.

What is more, if you look back, the last element which we set out to conquer was the sea. Mr. Ashbolt said just now that it was possible to start at sea on a small scale, whereas in this airship business you must start in a very big way. Generally speaking, I agree with Mr. Ashbolt; but if you look back to our entry as a nation into overseas commerce you will discover that what he says is not true. We entered on a scale which individual merchants could not undertake. We had precisely the same problem then as that which is before us now in reference to air. In the last years of Edward VI. the merchants of London—I think it was chiefly London, but I will simply call them merchants—were granted a charter and a monopoly of trade. That was how the trap was baited for them: they were granted a monopoly of trade to find a passage north about China, and they fitted out a small armada and set forth. They did not find the passage, and we still have to find it; but they did find our overseas trade. They found Russia, and through Russia they found India, and the whole thing followed right on. That was the beginning of our overseas trade. Edward VI. was dying when they sailed down the Thames, and just to show you how rudimentary was the stage they had reached, it took them, I think, two or three months to get to Orfordness. There you see the earliest attempt in the last year of Edward VI., and you find, when his sister Elizabeth was still an active woman, that the Armada was defeated. There you have commerce encouraged by the power of the State to give it something to make it go on and, in a very few years from that, the nation was great in war at sea.

Exactly the same thing will follow in the air, I believe, and the experience of the Air Ministry, if I might just introduce that critical note, is proving to-day in a negative sense that if they devote themselves to the military side they do not get the results they want and they crush the development which they wish to push on. I do not want to say anything more of a critical nature; but inevitably when Commander Burney comes out with his scheme, as I hope he will—I know nothing about the ins and outs of it—the first criticism that will be made is this: You have spent millions, the State has spent millions on these airships, and what have they done? They have done literally nothing. They have not proved that they can do the simplest service. Since the War, since the Air Ministry was placed in charge of these airships, the airships in existence have been put into their shelters and left slowly to decay. That is a very serious criticism on the part of anyone who is asked to embark four millions of money, and by Commander Burney and those who think as I think that this method of travel has great possibilities and ought to be tried out, that point has to be faced.

What is the reason for it? Is it inherent in the airship that it can only be built at immense cost and then left to decay? Is that all that is its duty in life? Or can it negotiate the air? I am not an expert at all, but all my life I have for business and for pleasure knocked about in boats and ships. I have also been in three or four of the different types of these airships, and I was immensely impressed at the way in which they rode the air, at their apparent stability and their handiness. The last time I was up was with a scratch crew under that gallant officer, whose death we all deplore, General Maitland. He gave me an opportunity of going up in the wooden airship—I forget what its name was. The crew was quite a scratch one. It was the sort of crew that, if put into a racing yacht, would have made a most frightful mess of it; but they did not make a mess of this job. It took some little time to balance her and so on, but at last away we went. We had all sorts of adventures because there was no wireless then to tell us where we were; but the impression left on my

mind was that the difficulties that obstruct the progress of airship development can and ought to be surmounted, that this method of travel has a reasonably good chance of going through, and that we ought to try it out. Well, gentlemen, we have not done so, and here we are, having spent all this amount of money and having got literally nothing for it. I think that is a deplorable position, and I very much hope that we shall not remain in that position for long.

The only other thing I wish to remark upon is the advantage we should derive from aerial navigation. You have heard Mr. Ashbolt, and I ask you now to hear me. You may think I am a competitor of this new thing, and so I am, but let us assume that it will make rings round the ships. What are the possibilities on the surface of the ocean? What we want to do, and what we have to do to foster imperial trade is to stimulate the trade of the country, and if we can enormously reduce the distances between the component parts of our Dominions we shall have done the very greatest service we can do to the world. My company, the Orient Company, have just placed an order for two new ships. They are going to be very expensive and they are going to be very fast, according to our lights, and therefore they must be very large. They will do nineteen knots. Here, on the other hand, is this craft in the air which Commander Burney says will do eighty knots. Of course, it will not do eighty knots against the wind, but then in these great oceans, by taking thought, you can get the wind with you, and if you have a forty-knot breeze with you and you are flying at eighty knots, you are really doing one hundred and twenty knots. It sounds very nice, but it is not a joke; it is a fact. You get regular trade winds, and all that would be necessary is to arrange your routes so as to have the wind in the right quarter. By that means the distance between ourselves and our friends in Australia will be reduced from to-day's minimum of, let us say, a month, to seven or eight days, and at a cost enormously less than we can look at in effecting an acceleration of three or four days on the ocean.

It almost scares one in approaching this problem to look at the advantages that can be got. They are so great that I almost begin to think that they have turned my head. When you have an airship which has no motion and no sound—that is a point which was raised just now by General Seely—and is comfortable, you will get to your journey's end as though you had the magic carpet of the Arabian Night. All those things are promised us by this mode of travel. But, of course, it is not proved, and it has got to be proved, Mr. Ashbolt says, on a dominion route. I do not care where it is proved; prove in the simplest possible place you can find that these ships will do, not all that is asked of them, but half of what is asked of them, that they are reasonably safe and reasonably regular, and I believe you will have any number of people wanting to travel as well as wanting to run them.

Sir Alan Anderson.

Captain ALFRED INSTONE (Instone Air Line, Limited): Your Grace, my Lords and Gentlemen, we were all very glad to hear the new Secretary of State for Air and your Grace say that you are both studying the various aspects of air policy, because we who are interested in this feel that you could only come to one conclusion—namely, that, in view of its national importance, it merits the utmost possible support from the Government in spite of the difficult financial times which we are experiencing. On behalf of the section of the industry in which I am interested, I must add my thanks to those already expressed to General Brancker for the most illuminating address he gave us on the present position of affairs. Last year we had the advantage of hearing him as a fearless and independent critic of the administration at that time, and we feel that since General Brancker has been in office he has brought us a step nearer to the goal of our hopes: that is, to see civil aviation running without a subsidy at all.

General Brancker, I think, invited frank criticism of his paper, and I hope he will permit me to give him a little to go on with in all friendliness. Before doing so, may I say how pleased we are to see Lord Gorell with us to-day, knowing as we do the large part he has played in bringing about the changes that have been made in the various routes that we now see before us, and it is particularly interesting to see a continuance of his interest in flying, of which we hope to have the advantage for some time to come.

Turning now to General Brancker's paper, I should like to echo Lord Gorell's suggestion, which I think was also made by Mr. Handley Page, that it is unfortunate to find that the scheme we are operating is still regarded as temporary. We had the pleasure of hearing, or it had been foreshadowed, that we were to be put on a more permanent basis, and it is particularly unfortunate to find each time this Conference meets that we are working under that vague thing, a temporary scheme, and at a most unfortunate time of the year. I would point out that, although it may seem rather a domestic affair, that this temporary measure affects not only those who are engaged in operating services but the aircraft manufacturers as well, on whom we depend to a very large extent. When I heard General Brancker's statement that the new signal of distress is to be "m'aidez," which he told us, meant "Help me," I foresaw that unless something was done to make this scheme something other than temporary most of the aircraft manufacturers would adopt those words as their telegraphic address. Although we are operating firms, we want to see the prosperity of the whole aircraft industry, and from my experience of the present arrangements, I can say that, although we are satisfied with the prospects of extending the routes, several new problems have arisen in regard to those routes.

We still have not got the real commercial aeroplane. In many respects I believe it must be considered still that an aeroplane is not an asset but a liability. You cannot

get an aeroplane to-day that will pay for its keep. One aircraft manufacturer said to me the other day: "Until we get orders so that we can keep our works going we have to put on the top of the charge to you civil people a lot of our overhead charges, which ought to be placed on other orders that we should get from other sources. We have no time to devote to trying new machines and new types." Undoubtedly, it would be a great advantage to civil aviation to see the aircraft manufacturing companies in a more prosperous position.

I should like to allude to another matter that General Brancker referred to—namely, the international position. We are very glad to learn that the International Convention is getting busy in reference to the new routes which are being opened up. When I go to Croydon and see the privileges, the advantages and the facilities that we offer to foreign lines which come to the aerodrome, whom we are very pleased to welcome in every way, and compare them with what we experience when we go abroad, in the matter of facilities and so on—although in every other respect our relations are friendly and we are welcomed—I think it is time that the foreign nations concerned should be reminded of their obligations to provide the same facilities for English aircraft as their own aircraft obtain when they come to Croydon.

Allusion has been made to the development of the various routes, and I should like to say, leaving Germany aside for the moment —I will return to it again before I finish— that other countries which are shown on the middle route on that map, including Czecho-Slovakia, have shown the greatest friendliness and the greatest desire to have British aeroplanes flying across their countries. They are ready, and I believe they have already offered officially, to extend a welcome to British aircraft because they know that by opening these routes in the air they are developing trade with the British Empire. With regard to Germany, General Brancker mentioned that he hoped, as we all hope, that Germany will join the Convention and simplify in all respects our arrangements for landing in, and going through, that country. But he did not say what would happen if Germany did not sign that Convention. Leaving aside international difficulties, it is a very anxious matter for all those engaged in developing routes, and I do not think we ought to be kept in a continual state of suspense and doubt until Germany makes up her mind in that respect. I hope that the Air Ministry, by negotiation, will be able to overcome those difficulties, because they must be overcome if we are to progress.

General Brancker also referred to the question of Imperial routes. I am rather surprised that none of the eminent speakers who preceded me criticised his suggestion that small aeroplanes should be used for that purpose. I know that the matter is still under consideration; but from our experience of developing routes where there are intermediate stopping-places, we feel that we want aeroplanes that can set down and pick up passengers very much like the international expresses are able to do. At the moment I cannot see how General Brancker's small aeroplanes are going to cater for the traffic we hope to obtain on those lines.

I should like also to make one remark, in view of the fact that General Brancker said he was open to receive suggestions at this Conference. Although we know that within their financial limitations the Air Ministry are doing a great deal in various directions for civil aviation, there is one department which, I think, could render still more assistance. I believe the official view is that everything in the nature of propaganda to popularise flying should come from independent outside sources, such as the Air League, whose work we know has been excellent in that direction. But there are some forms of propaganda that a Government Department can carry out better than private bodies, and I want to give you an example. On a couple of letters I received last week I noticed that instead of the ordinary post-mark one of them bore a post-mark which said "British Empire Exhibition, 1924," and the other, which came from Ireland, the post-mark "Learn Irish." If a Government Department can afford to use that method of publicity it occurs to me that it would not be a bad idea if someone at the Air Ministry could use his influence to induce the Post Office, when this Conference is sitting, to post-mark letters "Travel by Air." If that was done for a couple of weeks or so it would indirectly help the whole industry.

I must, I know, put on record our indebtedness to the Press in general for what they have done for aviation. We are greatly indebted to the Press, and we recognise what they are doing. But when the Lord Mayor told us yesterday by way of a joke, that his successor at some future time might see an aerial Lord Mayor's show it occurred to me that there is no need to wait until the Lord Mayor flies round London. It ought not to be above the imagination even of one in office, as General Brancker has said, to suggest that part of the present Lord Mayor's Show might be taken up occasionally by a demonstration of what has been done since Blériot flew across the Channel. It would give the public an idea of what is happening, because every member of the public does not go to Croydon.

As to the problems of the future, I would like to put it on record that I was very much struck with what Mr. Handley Page said just now, that for two years his Company had not had an insurance claim. I think that is an excellent record for that particular line. There are other lines also—I may, perhaps, mention the de Havilland Company and Daimler—who have done remarkably well under difficult conditions for civil aviation. And if one is allowed, notwithstanding that one is an interested party, to make a remark regarding one's own operations, the Instone Air Line has not had a fatal accident since they started operations, which shows that the question of safety has reached a stage as to

which we can feel satisfied. General Brancker also gave us some most refreshing news. He said that there was an Australian company which had paid a dividend. We all hope, and we all feel, that the time is approaching in this country when, through the co-operation of the Air Ministry, of aircraft manufacturers and of engine makers, we ourselves will certainly be able to put the whole industry on a commercial basis. When we reach that day of dividends it will be a red letter day, not because of the intrinsic value of our reward, but because it will show that the sacrifices made by all those engaged in this industry, with the co-operation and patient plodding of all those who have put their backs into the development of this young industry, have enabled it to reach the day when it is fit to stand on its own feet and act as a speedy and useful means of communication of national importance, not only for this country but for the Empire.

Admiral MARK KERR, C.B., M.V.O.: My Lord Duke, My Lords and Gentlemen, General Brancker is developing a permanent blush by reason of the bouquets that have been thrown at him. I have prepared a bouquet, and I think I must throw it at him also. His paper yesterday was full of interest and some hope. He said that as a Government servant he was not supposed to have any imagination; but I congratulate the late Government not only upon not having let him go because he possessed that quality, but upon having brought him back again in spite of his having it, to the very great benefit of commercial aviation, and I might also say, for the safety of the country.

Now let me bring forward one point on which nobody so far has yet touched. They talk about commercial aviation as if it was being got up for the benefit of the trade. It is not so. Commercial aviation will benefit trade when it is got up, but that is not the reason why the Government ought to assist it. Commercial aviation is the one great backing to the military power of the country, and the Government should be made to know it. It is a truism that we may have the finest Navy and the finest Army in the world, but we can be struck in the heart of the Empire here before the Navy and the Army can come into action at all, and the Government have to be made to understand that. It is not their fault that they do not, because most members of Governments are not brought up in a military service, but it is an obvious thing, and no one has contradicted it, because nobody can. London is as vital to the Empire as his heart is to a man and we can be struck in the heart from any country within air reach.

A short time ago an attaché of a neighbouring country which is ahead of us in military and civil aviation, talking to a friend of mine in a friendly way, said: "We do not mind what happens now, we have command in the air," and who could deny it? That is not a thing which was said with anything against us, but it is a fact, and it is a fact the people of this country ought to realise; they ought to insist that the money that is supplied for the protection of this country is spent in the right way.

Lord Gorell just now rather laughed at Commander Burney for having begun his paper by referring to the early days of the Navy. I think that Lord Gorell was wrong because, unless you understand what happened in previous times, you cannot expect to have the knowledge that some members of the Government have who have studied these things and understand why Commander Burney referred to the early history in order to show how it applies at present. Think for a moment. If these various changes had not taken place we should still be dressed in skins and armed with bows and arrows and other things which are not applicable to the present day. We should also have wooden battleships which are not exactly applicable to the present day. Man started with his claws and teeth. He found that they were not long enough, so he took to the knife. Then he tied it to a staff and made a spear of it. Then he threw it. Then he put a string on another piece of wood and made a bow and increased the range of his weapon. Then he made gunpowder. For what reason? To extend the range.

Commander Burney was trying to explain why the battleship is obsolete. The reason he gave was that it has only a range of twenty miles, whereas an airship will carry the most deadly weapon of all for two hundred miles. That is only going back to the beginning and extending your range. That is why, in my opinion, we ought to have in this country a Ministry of Defence. The other day we expended sixteen millions sterling on two ships which will never come into action, in all probability. Ten million pounds of that money would have put us safe in the air.

Now flotillas of air and sea and underwater must be given consideration. It is not possible to do away with ships, but it is possible to sink them by other means than with ships. The late war showed that flotilla had entirely changed naval tactics. Battleships had to go to sea escorted by destroyers which would have been much better employed in sinking submarines. The only real answer to the submarine was the flotilla of the air and the surface. That is becoming more and more, as time develops, the work of the Air Service.

The cheapest way of getting your Air Service is to have a great commercial Service. Commander Burney also pointed out the earliest history for the same reason. Our Navy, as Sir Alan Anderson said just now, was started by the Merchant Service, and the Merchant Service formed our greatest reserve in the last war. Without them we should have gone under. Commercial aviation should be assisted by the Government until it can run on its own feet, in order that there might be that great reserve of pilots, factories and mechanics which cannot be made in a day Do not let us put it to ourselves or to anybody else that all this is being done for the sake of the trade. That does not appeal to those engaged in other trades and to people in other places. Frighten the people of this country and let

Capt. Instone.

them frighten the Government. It is the only way of getting anything done. But frighten them truthfully, and let them know and explain to them why it is. Strategy is no strange thing. It is commonsense applied to imagination. We know imagination is rare in a Government, because General Brancker has told us so. But do not forget to teach the public these things. Do not tell them because you are an aircraft constructor or anything else, but let them understand from you as a citizen the plain simple laws of strategy, speed and range, and that the speediest thing with the longest range is the Air.

Other services will come in at the finish, like the Navy. No war has ever been won by the Navy, but no war has ever been won without it, because it commanded communications. But communications have now passed from being confined to certain kinds of transport on land and to certain kinds of transport on the sea to the aircraft which goes over both land and sea with equal facility. That is the reason why air has become of the first importance and not, as our Estimates show, of the last importance in the defence of this country.

There is one other thing about safety in the air that I should like to mention. During the war a Committee was appointed, consisting of General Sir Geoffrey Salmond and myself. a Committee of two; very nearly the best Committee, but not quite. Mr. Calthrop was one of the people we sent for to produce something to save our pilots. A Canadian Brigadier told me that the thing that hurt him most and which remained with him for the whole of the rest of the war was seeing eleven of our machines on fire in an air fight, and eleven British pilots jumping out at 11,000 feet and crashing to their deaths around him. That was in early times, and that started me on the subject of parachutes. I was, for my sins, or for other reasons, sent to the Air Ministry, and I took up this question. I got no assistance from above, but, thank the Lord, from the East came General Salmond, and he agreed with me, and Mr. Calthrop was sent for. General Salmond with his knowledge and intuition put his finger on the weak spot at once and asked for a stream-line case to be made for the parachute so that it would not take away from the speed of the machine. In five days, I think, Mr. Calthrop had invented it and brought it back. I have no hesitation in saying that we lost several thousand pilots in the war through not using parachutes. We know that the Huns and our enemies generally saved many hundreds of pilots through using parachutes. Apart from sentiment, it is very bad commercially to train a man, to spend £300 or £400 on making him a pilot and then to chuck him and the money away for want of spending £35 on a thing which does not reduce the efficiency of the machine.

Some time ago the late Secretary for Air promised that our fighting machines should be fitted with parachutes. I think I am right in saying—I am open to correction—that not a single machine overseas on service now is fitted with a parachute. Commercially it is extremely wasteful; sentimentally, it is horrible, and for the nerves of the pilots it is distressing. Colonel Barker shot down two enemy machines in one afternoon, and each time the pilot went down on a parachute. Colonel Barker came back and said to me: "By the Lord, if there is another war I will refuse to go into the air without one." He was not a person who suffered from nerves. I spoke to a great many pilots, old and young, during the war and each one of them said to me: "For God's sake get us a parachute."

My last word to this Conference is, let us all pray fervently—even if you do not go to Church pray fervently in your inner chamber—that the rare gift of imagination may be given to the Government; that the rare gift of courage may be given to the people, so that they may thrash the Government until they give us what we want. Genius is a rare thing. It may be described as the capable application of great imagination. Now will those of you who have imagination send it up to the Government in an envelope and get the people of this country by their votes to give capable application to that imagination, and we shall have a Government of geniuses. Let us hope that we shall still see the present Under-Secretary and my friends opposite, who have done great things for the air, in the same place next year, rejoicing with us all that imagination has come to the Government and that the capable application has been undertaken by them.

The CHAIRMAN: I am sorry, gentlemen, that in the interests of time I shall have to ask the remaining speakers to limit their remarks to five minutes or round about that.

Mr. T. J. FAZACKERLEY (Northern Aviation Club): Your Grace, My Lords and Gentlemen, My remarks will sound very parochial after those which have been made by the pioneers of aviation who have done such a great deal for that science in the past. This is my first Air Conference, but my experience in aviation dates from practically the first venture in civil aviation, immediately after the armistice when for nine months the Air Force tried to run a service between Germany and England. Had the pilots and flying personnel concerned in that experiment known what that experiment meant—they were all war-weary—and had the heads of the Air Force not scuttled out of that force in order to join the boards of commercial companies, they would probably have been able to give the benefit of their war experience to the Government, and I do not think civil aviators would have been in such a pessimistic mood as they are to-day.

A great deal has been said here during the Conference about the financial success of a civil aviation company depending upon the support of the public. I appeal to everyone present who has any influence with the authorities in the provinces—and there are some great commercial towns outside of London—to convey the spirit that was shown in the remarks of the Lord Mayor when he promised to do all he could to assist and to foster the success of civil aviation. If we can get the Mayors of the various towns of

England, and the people in authority, to act on that sentiment, we shall have done a great deal towards popularising commercial aviation. The Secretary of State for Air held out little hope of further financial assistance. Some of the speakers have expressed their wonder that we have not had a scheme. In my experience of the Government it will probably be issued after this Conference, so that it will not have to stand, as probably on some points it would not be able to do, the criticism that this experienced body could and would have made.

Though the Secretary of State for Air gave civil aviation his blessing and promised his support very little that was definite was said regarding that financial support without which civil aviation does not seem to be able to get very far. The commercial and financial world is not likely to assist at the present stage by putting money into the movement. That brings me to what I have always maintained ever since I was on the experimental aerial service between Germany and England—which ran, by the way, for nine months—that we must educate the public to the advantage of aviation by the practical illustration of the saving of time in mail carrying. Nearly every speaker on the subject of aviation refers to mail carrying as an asset; but I refer to it as a means of bringing home to everyone in this country and in our Colonies the possibilities, through aviation, of express baggage transport and other traffic. We must enlist the sympathy and co-operation of the Postmaster-General's Department. The Government ought at least to support one of its own children, and can do so by facilitating collection and delivery at terminals. If the same energy and methods by which the success of the Imperial Cable was ensured were to be at the disposal of the aerial post, I think we should have a notable increase in the support of aerial commercial experiments.

Some time ago I put to the Civil Aviation Department certain advertising ideas. I suggested that they should advertise on Government premises, street mail-vans, and in the stamping of letters, but these ideas have not yet been adopted. The Postmaster-General's representatives watched closely the result of the original experiment and certainly, on the result obtained, could not support the idea. The Post Office must keep faith with the public and give a one hundred per cent. efficient service to the public. It is of no use blaming the Government Departments. The representatives of the people are in Parliament and if you do not give the people the hundred per cent. efficiency which they demand and for which they pay, their spokesmen in Parliament can criticise the Department concerned and refuse to vote the money for any necessary experiments.

After what we have heard about the success in America, Australia and even of our own Service between Cairo and Baghdad, it appears to me that the public might have the advantages of aerial transport put clearly before them. I am told that our aviation people engaged in the East convey the information to their people at home about the advantages of air transports. If we do that to a larger extent here we may get this result—that people who send correspondence will pay an extra fee to have their letters sent by that Eastern aviation route. There are provincial towns like Manchester, Leeds and Liverpool, which carry on an extensive trade with the East through the post and send samples and valuable parcels. The people of the provinces are not as familiar as Londoners are with aeroplane services and what they mean. Steamship companies, as well as railway companies, used to receive subsidies from the Government ostensibly for mail-carrying, which certainly were a financial loss to the Postmaster-General's Department. But that loss was more than compensated for by the crews of those ships being a reserve for the Navy in time of war. Could we not apply the same principle to the mercantile air service?

My remarks in all cases about mails apply to the newspaper service to which the mail service is almost akin. I would also urge the commercial aviation syndicates not to leave it all to the Government but to do as the railway companies and steamship companies do—canvas for the carrying of goods and passengers. The railway and steamship companies of to-day, although they have been established for so long, still carry out that idea. A leaf might also be taken out of Messrs. Marconi's book in regard to wireless. Whilst they are endeavouring to get what they can out of the Government, they are helping themselves by a publicity campaign. I would on this point say that as soon as the armistice was declared Marconi, who saw the future of aviation, immediately sent his people to our Government stations to bring them right up-to-date before they ultimately went into the commercial world, which our own people did not seem to grasp. If, as I said before, the heads of the Air Force had not scuttled out of that Force at the time they did, the Government, in all probability, would not have been frightened at the cost that appeared to loom before them in the manufacture of aeroplanes.

Before I sit down, may I make a few suggestions. Civil aviation must be made self-supporting and it is time that we made a move towards attaining that end, no matter how small. Then, attention ought to be focussed on its advantages by means of Press notices, addresses to Chambers of Commerce and to Rotary Clubs and such like circles of business men.

The co-operation of the Postmaster-General ought to be obtained and last, but not least, that of the flying personnel and Government staffs. It would be as well to have sympathetic go-betweens, in other words, liaison officers, between the commercial world, the Post Office, and the air transport companies, a practice which was found so successful during the war. If all the different elements are brought together in the best possible way the success of civil aviation is a practical certainty.

THE CHAIRMAN: I call now upon General Williamson to reply to some remarks that have been made about postal matters.

Brigadier-General F. H. WILLIAMSON, C.B., C.B.E., (G.P.O.): My Lord Duke, my Lords and Gentlemen, I should like to make a very few remarks from the postal point of view in reference to civil aviation in 1922. May I first of all reply to the criticisms of the speaker who has just sat down, which were to the effect that the Post Office does nothing in the way of getting proper publicity for the air mail services. In the first place, if communiqués in regard to what is done in various ways are not mentioned in the Press, for instance, the Government can hardly be blamed for that. In the second place, in the middle of the year we prepared a very clear and, what I venture to think, was an attractive summary of everything that was being done in the way of carrying mails by air. Nearly 200,000 copies of that summary were actually delivered at the offices and business houses of London and sent to every large town in the country. That was followed by a drop in the despatches, and if that publicity was of no use I do not think it is quite fair to blame the Government for it.

From the postal standpoint I am sorry to say that 1922 was a very disappointing year as compared with 1921 in the matter of the Continental services. There was a very serious decrease in the amount of traffic conveyed. The Paris service went down by 41 per cent. The Brussels service, in which the conditions were rather exceptional, decreased by 60 per cent. and the service to Amsterdam went down 3·3 per cent. The reason is that so long as aeroplanes run over such short distances they cannot be made of very much use for mail purposes. They can only serve as a supplement to the regular means of communication and for the benefit of that very small amount of urgent correspondence which can be posted early in the day for delivery on the same day at its destination.

One really interesting thing is the establishment of a parcels post service to Paris. That has been a very distinct success. It was run with the co-operation of the Instone line and then of the Handley-Page line. It has shown steady progress all through the year, each quarter showing a marked increase on the preceding quarter. The figures for the December quarter, 1922, show an increase of 200 per cent. over the corresponding quarter for 1921. We think there is quite a considerable future in that direction because the gain in time is very substantial; it is something like a week and it offers a very real facility to senders in this country at a comparatively cheap rate. The most successful service, of course, is that between Cairo and Baghdad, which has shown a progressive increase all through the year; in fact, the returns for the December quarter show an increase of more than 600 per cent. over the December quarter of the previous year. It is only fair to point out that conditions are quite exceptional. The gain in time is as much as three weeks. But it is right to say, by way of *caveat*, that it cannot be considered as showing that commercial aviation is yet possible there as a financial proposition. The fee is low; it is only sixpence an ounce, and the total receipts from inward and outward traffic amounted to something like 200*l.* a trip, which was clearly utterly inadequate to contribute very much to the cost of a service of eight hundred or nine hundred miles in each direction between Cairo and Baghdad.

Lord Gorell mentioned the case of the United States Post Office. The United States Post Office is really working under conditions which we can only look at as a rather distant ideal. The distances in the United States are so great that it is possible to take the very fullest advantage of the gain in time which is given by the high speed of the aeroplane. At the same time the volume of mail is quite considerable. It is possible to carry a full load and thereby to reduce the cost per pound carried. It is rather difficult to make out from the statistics available, precisely what is the cost of the service. It is probable, however, that under those extremely favourable conditions the cost of air transport does not very greatly exceed, if at all, the cost of transport by train, which, as a matter of fact, in the United States is extremely high, so far as mails are concerned.

The result of the general experience of 1922 has been to drive the Post Office to the conclusion that so long as aeroplanes are limited to short distances they are of very little use for the carriage of mails. They can only be useful when you get long distances and night flying. What one can look forward to is the time when there will be night services working from London to every large Continental town within, say, seven hundred or eight hundred miles of London, when letters posted at the end of the business day in London will be delivered in the course of the next morning at Stockholm, Berlin, Christiania, Hamburg, Copenhagen, and other great cities within the radius I have just mentioned. That is a development to which it is quite legitimate to look forward; but until we have night flying, long distance journeys and incidentally lower costs, I do not think it is possible to look forward to any very considerable development in the way of mail carrying by air.

Sir HENRY WHITE-SMITH, C.B.E.: Your Grace, My Lords and Gentlemen, time is short, and, therefore, I will confine my remarks to one aspect of the question of commercial aviation which has not been touched upon to any great extent. The point I wish especially to deal with is the need for greater research and experimental development. Captain Instone, a few moments ago, said that we have not yet got the commercial aeroplane and I agree with him entirely. Until we get a commercial aeroplane it will be very difficult to see that economy of running which will produce commercial results and that reliability which will bring passengers and traffic, and the safety which will inspire the public to use the air service to a greater extent. I think we ought to direct more attention to this foundation work of research and experiment in order to

achieve our results later on. Money spent in that direction at the present time will be more than repaid in the economy in subsidies which will result at a later date.

One difficulty to-day is that we do not quite know what is required in the shape of commercial machines. It is not clear whether small machines carrying eight passengers, or large machines carrying twenty or thirty passengers, are required: whether you want low speeds with heavy loads or high speeds with lighter loads; whether you want heavy engines with infrequent overhaul or lighter engines with more frequent overhaul. Ideas on those subjects and as to what is a desirable aeroplane for commercial work are very hazy indeed and I think they want clarifying. In this connection the Civil Aviation Advisory Board lately made a recommendation to the Government that a Special Committee of the Aeronautical Research Committee should be set up and that funds should be placed at their disposal for a more complete investigation of the needs of commercial aircraft. I wish to emphasise this because I think it is foundation work which has to be done at the present time. This Committee, working of course in conjunction with Sir Geoffrey Salmond and his staff and General Brancker and his staff, can do most valuable work. On this Committee can sit not only technical experts but representatives of the transport industry who have practical experience of operations. The setting up of this Committee will, I think, do a great deal to help forward the more rapid progress of aircraft development for commercial purposes. The great thing is that this work shall be intensive; that is, that the Government shall set aside sufficient money for the work to be done in addition to and independently of the military work which will be necessary later on in certain directions. It needs to be specially intensive in regard to civil aviation.

There is just one point I should like to make to-day and I think it is a most important point. I was very glad to hear the Secretary of State for Air say yesterday that a point which he regarded as of the first importance is research. Research and experimental development are the first things to be done if we are to make our civil aviation a success financially and from a popular point of view develop it throughout the world. Reference has also been made to the succession of Air Ministers who have presided at this Conference. But there is one aspect of that which I think is of great advantage, and that is that so many members of the House of Lords and House of Commons have been and are being educated in aviation. I think it is full of hope that a great interest in the air is being developed in the Houses of Parliament and that the Members will see that aviation holds such an important place in our imperial life. There is, therefore, the more hope that it will be supported.

Major H. Hemming, A.F.C. (Managing director of the Aircraft Operating Co., Ltd.):

Sir H. White-Smith.

*[My Lord and Gentlemen, owing to the fact that the London–Continental air routes operate as it were on our doorstep, there appears to me to be a tendency to forget that great field of development that awaits the British aircraft industry; I refer to the development of aviation in our Colonies. The London–Continental routes are very important both from an experimental point of view and also as the first link in a chain that we hope to see extending to Egypt and India, and later to South Africa and Australia. But I question if it is an economical or wise policy to spend vast amounts of money and time in carrying a small number of passengers and mails on cross-Channel routes which are already well served by other means of transportation, under what are possibly some of the most difficult flying conditions in the world, especially when we are informed that most of the passengers are American citizens, and not our own countrymen.

Our people are naturally conservative; there is no doubt that the majority of passengers between England and the Continent will patronise the boat and the train until the time comes when the insurance companies will give the same premium to the aerial traveller, as to the traveller by the older forms of transportation. The figures that the Director of Civil Aviation has given would appear to bear this out. Before the aeroplane can compete with a well-served route it must hold out greater attractions in comfort, cheapness, safety, and all-round efficiency than it does at present. Still the London–Continental route must be kept running, but it should be on a strictly economical basis, so as to release some of the public funds for assisting the development of British aviation in the Colonies, where the chances of getting something back for capital expended are far greater. There are many parts of our Empire where communications are at present totally lacking, or very inefficient, which would considerably benefit from an air service. Increased or new communications if intelligently organised would be followed by an increase of trade. So far, the pioneering of British aviation in the Colonies has been left entirely to private enterprise, and the Air Ministry has concentrated on the London-Continental services, as far as direct financial assistance goes. I do not of course include such countries as Australia and Canada in this statement.

I do not advocate unhealthy subsidies for the furtherance of Colonial aviation, they merely spell inefficiency, but I do think that very great assistance could be given if the Air Ministry would provide aircraft to approved British companies on the same basis as they do to the London–Continental service. It has been my experience that it is possibe to get mail contracts and other concessions if the route is likely to be of any value to the Colony concerned, and the extra help that the Air Ministry or the Imperial Government could give would make some of these routes

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* Papers included in this Report, but not read at the Conference are enclosed in square brackets.

commercially possible. Some of our Colonies are very wide spread, and on account of this most difficult to administer, this problem can be solved by the use of aircraft.

The aeroplane and the flying boat offer a means of opening up and surveying great tracts of country which have not been surveyed hitherto. Apparently Canada has made great strides in this direction; one understands that they have corrected large portions of the map by aerial photographs, while patrols for the survey of timber and for forest fire protection are of daily occurrence. From the advertisements and literature that one sees on the other side of the Atlantic one gathers that the United States also realise the great importance of aerial surveying. I question if the British public know of the value of aircraft for survey and exploration work. They know that aircraft play a great part in warfare by bitter experience, they know that aircraft carry passengers and mails because of the Government subsidised services to the Continent and the fact that these services have in the past always formed the greater part of the official papers at the Air Conference, while the press have always given great publicity to these home services. I submit that a statement of the work done by British aircraft abroad, and the possibility of using aircraft for the development of our Empire should be made by the representatives of the Air Ministry at the next Air Conference, so as to get the public to realise the potential power of aircraft as Empire builders.

It daily becomes more important that the resources of the Empire should be made as much use of as possible, this is where aircraft can really be of valuable help. Very useful photographic maps can be made of country that has hitherto remained unexplored, owing to the enormous expense or impossibility attaching to the carrying out of a ground survey. It would be foolish to claim that aircraft can do away with ground surveying, that time, if it ever comes, is many years ahead; but aircraft make a survey possible where it is impossible to carry it out by the ordinary ground methods, and although this survey cannot approach the accuracy of an Ordnance survey, yet it can be of the greatest possible value, especially when the speed at which it can be made is taken into consideration.

By the study of vertical and oblique photographs a wealth of detail can be learnt of the country depicted. For example, where the country is made up of jungle and marsh the air photographs will show the prospector the most likely route to take if he wants to reach his destination in the shortest possible time, and with the least inconvenience. I know of a case where a prospecting party set off on a line survey through the jungle, they travelled for many days without being able to get a view of the surrounding country owing to the thick vegetation, they were unable to reach their objective as they came up against an impassable mountain range, the sides of which were covered with thick timber, so they had to return having wasted much time, and taken great risks, without having accomplished their purpose. It was found later that if they had struck the mountains a little to one side they would have found a pass, and so got through. I merely cite this as an example, there are many others; a series of oblique photographs would have shown this pass, in fact aerial photographs would have given all the information that was required and possibly more of it.

Take the case of the business man who is interested in timber, say, in the Labrador. He wants to inspect a limit that someone is trying to sell him, he gets to St. John's, Newfoundland, and then finds that he must charter a boat to take him some 500 miles to his destination, his party must include guides and enough food and equipment for a long stay if he wants to see anything of the property. By chartering a seaplane he can reach the limits in a few hours and inspect the whole of them from the air, the pilot or observer will in the meantime take aerial photographs. After landing to inspect a portion of the limits on the ground, and to take a few measurements, the prospector can return and examine the photographs at his leisure. By noting that portion of the limit that he has inspected, on the ground, on the mosaic of the limit he will be able to get a very useful idea of the other portions of the limit shown on the photographs. All this can be done in the space of a few days if the limit is a small one, as against several weeks or months by the old method.

Personal experience leads me to express the opinion that an economically organised aerial survey circus, run by people with the necessary experience, could secure sufficient contracts in different parts of the world to warrant its formation. The circus would consist of specially trained pilots and observers skilled in aerial survey work, an expert ground surveyor, and the necessary photographers. The circus would move from one contract to another. Very little encouragement is needed from the authorities to make the creation of such a circus a fact, and any official help would be amply repaid by the valuable data that would be secured. The English Ordnance Survey is usually admitted to be the best in the world; let us try and secure the same reputation for British aerial survey work abroad. There is no great future for aerial surveys in this country as every inch of it has been covered by the Ordnance Survey. I have heard it suggested that this work could be done by the Royal Air Force; undoubtedly it could and very well too, but I submit that this is essentially work for civil aviation, and must be run on a commercial basis to be a success.

I am convinced that it would greatly benefit this country if the value of aircraft for the opening up of the Empire, in addition to their value for transportation purposes, were properly brought home to the public. At the present time civil aviation is far more likely to pay indirectly than directly; by that I mean that the increase in trade or in the finding of fresh resources, that the use of aircraft is likely to bring about, will give far greater profits to the particular country and the Empire than it will to the people operating the aircraft, therefore, to make it possible to operate aircraft commercially some sort

of useful encouragement must be given by the Imperial Government. I am sure that everyone who is interested in civil aircraft operations will agree that the officials of the Civil Aviation Section of the Air Ministry are most helpful in every way, especially in giving information. All that we now want is some progressive policy for the development of Empire aviation not necessarily restricted to air transportation.

The finest insurance policy that this Empire can have is an efficient air fleet. We do not want it to be an idle air fleet in peace time. A small but highly efficient Air Force backed by a Civil Air Fleet which is earning its keep in peace time seems to be the ideal which we should aim at. The Imperial Government could make the creation of such a reserve possible by giving encouragement to Colonial aviation, in consideration of the machines and personnel being at the Empire's disposal in time of war.

It is essential that we keep our aircraft manufacturing industry alive. It cannot thrive on the Royal Air Force and the London–Continental services alone. Let us once develop Empire aviation and our manufacturers will have the field that they require to enable them to put the industry on a sound basis. Before closing may I again beg that more time be devoted to the discussion of Empire aviation at the next Air Conference.]

Mr. E. R. CALTHROP, M.Inst.C.E., M.I.Mech.E. : [The Air Conference of 1920 was notable for important official statements, in connection with parachutes, made by a no less notable personage than Air Vice-Marshal Sir E. L. Ellington, Director General of Supply and Research. On page 65 of the Proceedings* you will find that he informed that Conference that the Air Ministry had decided that single- and two-seater machines of new types of aircraft for R.A.F. use would be provided with parachutes, and that existing machines of these classes would be so equipped where possible. He further informed the Conference that the equipment with parachutes of machines, which would carry a large number of people, so that they could be relied upon to function properly for each person carried, was a problem that had not then been completely solved; but it would no doubt be solved in due course. In my speech made at that first Air Conference (*see* Proceedings,* pages 73 to 75), I set out the reasons for the adoption of parachutes upon civilian aircraft, and the bad effect of crashes, mostly military, upon the man in the street. I pointed out that as regards the big machines carrying many passengers, I had tackled this great problem as far as I could go without Government assistance, and stated that I believed that even the biggest problem of the machine carrying 50 or 100 passengers was capable of a satisfactory solution. Four months later I handed in this solution (which had taken more than two years to work out) in the completest detail to Air Vice-Marshal Sir Edward Ellington. This was my Cabin Parachute for aeroplanes and airships.

The Second Air Conference of February 1922 was notable for the fact that a dead set was made against parachutes by nearly every speaker connected with the Air Ministry. It was obvious that the word had gone forth from the "high-ups" for parachutes in any shape or form to be damned. And accordingly they have been damned most effectually, for the promise made at the first Conference was not carried out, and on the 17th of June last Captain Guest informed Sir William Joynson-Hicks that no fighting aeroplanes had been fitted with parachutes. It is nevertheless notorious that nearly all military pilots and observers desire to have suitable parachutes as part of the normal equipment of their machines, yet none were sent out to the Straits on the machines equipped on a war footing.

The present Conference of 1923 is distinguished by the fact that in the Synopsis of the Papers to be read not once is the word "Parachute" even so much as mentioned. Officially the parachute is dead and done for. As the subject is not in the programme it can hardly be discussed, except with the special permission of the Chairman, by whom I hope it will be accorded.

Observe the ignoble descent of the parachute as a topic of discussion! Introduced at the first Conference by the highest technical authority of the Air Ministry with all due honour and respect: at the second it seemed to receive a kick from every official, and the only defenders were private speakers not afraid to appear as advocates. In the present Conference the defence of the parachute has descended so low that it is in the hands of an individual, whose work on parachute invention experiment and research may possibly be regarded by the Air Ministry as of less value than the smallest copper coin of the realm. Nevertheless, I have something to say which I think may attract the attention of most people in this room, and in particular the insurance interests, and the air transport services.

I beg to hand the Chairman, for submission to this Conference, an Analytical Chart with particulars of aeroplane crashes and casualties, etc., occurring in the month of January 1923. I have further copies here of this chart for the press, and for any concerned who may desire to study them. The chart contains, in respect of each crash, simply the facts as recorded in the newspaper telegrams and reports. It is absolutely unvarnished, unbiased, and these bare facts constitute its strongest argument. It will be seen that none of these machines were provided with parachutes; and consequently parachutes were not available. But I think it proper to say—and I believe that many in this room who have practical knowledge of parachutes will agree with me—that if these machines had been provided with adequate and suitable aerial life-saving apparatus, at least 50 per cent. of these deaths and injuries would not have occurred. I would like to ask the Conference to say whether the saving of 50 per cent., and perhaps all of these casualties,

* Cmd. 1157 of 1920.

Major Hemming.

Analytical Chart with Particulars of Aeroplane Crashes and Casualties, &c., which occurred in the Month of January, 1923 (abridged).

Prepared by Mr. E. R. Calthrop, M.Inst.C.E., M.I.Mech.E.

Date and Place of Crash.	Aeroplane, Type, &c.	Killed and Injured.	Particulars.
10th January - Great Britain. Stanmore Common.	D.H. 16. To carry six.	Pilot and mechanic killed. Two mechanics dangerously injured and one slightly injured.	Machine, a new one, was flying well, until it appeared over a field by Grove Farm, near Stanmore. It was then seen to nose-dive and crash from a height of about 300 feet.
10th January - France. Attieto (12 miles from Ajaccio).	Postal seaplane. To carry six.	Pilot and three British passengers killed; wireless operator severely injured.	One of the wings fell off at a height of 600 feet. The machine was seen to turn several somersaults and then crashed into a thick wood.
14th January - U.S.A. (20 miles off Havana).	Seaplane "Columbus." To carry six. Flying between Key West, Florida, and Havana.	Four passengers killed and two rescued suffering from submersion and bruises.	Engine failure at height of 200 feet.
19th January - U.S.A. Catalina Island, California.	U.S. seaplane. To carry four.	Pilot and one mechanic killed, two other officers injured.	Nose-dive from 2,000 feet ending in a crash on to rocks.
19th January - France. Nevers.	French Army aeroplane, two-seater.	Pilot killed, one mechanic badly injured.	Shortly after taking off struck trees and crashed in flames.
19th January - France. Rabat.	French Army aeroplane, two-seater.	Two killed - - -	Machine took fire whilst flying at 6,500 feet, and crashed.
19th January - France. Belleville.	French Army aeroplane, two-seater.	Pilot and one mechanic seriously injured.	Came down out of control.
19th January - Spain. Barcelona.	French mail-service, two-seater machine.	Pilot killed - - -	Struck tree while coming on to land.
20th January - Great Britain. Ladywell Recreation Ground, Catford.	Bristol Fighter, two-seater.	Pilot injured (broken nose).	Machine went through trees, crashed and turned turtle, and fell with one wing in a stream.
22nd January - Turkey. Smyrna.	——	Two killed - - -	Crashed during flight at Smyrna, and the occupants killed immediately.
30th January - U.S.A. Mount Clemens, Michigan.	Single-seater -	——	Pilot, when flying at an altitude of 19,000 feet, became unconscious owing to the extreme cold, and lost control of his machine, which began to descend rapidly. When within 400 feet of the ground he regained consciousness, righted his 'plane and escaped uninjured.
31st January - Australia. Port Hedland.	Mail aeroplane -	One killed - - -	Pilot and two passengers escaped unhurt.
31st January - France. Boulogne.	Passenger aeroplane from London.	——	A passenger-aeroplane from London with five passengers was forced to land near Boulogne at 2.30 owing to weather, and was damaged in landing. No one hurt.

would not be the best demonstration of "Safety in the Air," and do more than anything else to encourage the business men to use aviation as a normal means of conveyance for themselves and their important documents.

The analysis of these crashes shows that practically every type of aeroplane, from the smallest to the largest, now in use, is included. The column of particulars shows that, with the exception of collision between two 'planes in the air, practically every kind of possible accident to aeroplanes is included, including fire in the air while flying at 6,500 feet.

The analysis makes two things perfectly clear. The first is that the public using the airways are attracted to the large machines carrying six and more passengers. Still larger machines are in course of construction; and consequently, if passengers for these larger machines are to be safeguarded from fire, breakage, and loss of control in the air, it is Cabin Parachutes carrying away the whole of the passengers elastically, without shock, and without any operation on the part of the passengers themselves, that must be used for this purpose. For insurance purposes it will be seen that for the first time this proposition brings the carrying of passengers in civil aviation within the scope of practicable business for the insurance companies, for the actual risk on all passengers, men, women, invalids and children, will be perfectly equal. There is no time to discuss the technics of the action of the Cabin Parachute, but the following brief reference to its effect upon passengers will give the Conference something to think about. The passengers will be in no way concerned with the working of the apparatus, or under the necessity of any instruction in relation to it (as no passengers can be trusted to carry them out in moments of excitement and danger). The cabin will be in the air in less than four seconds from the pull of a lever by the pilot. The apparatus will not be visible to passengers, and in the first few moments of its action panic cannot prevail, as, although there will be no sudden shock, passengers will be physically unable to rise and move from their seats, on account of the arrestment of their momentum. Time will, therefore, be afforded to the occupants to regain their composure before reaching the ground.

The second point is that single-unit parachutes cannot be of life-saving service for passengers on big machines. They can only be of use for saving life in single and two-seater military aeroplanes, and, on occasions, from a big machine where a single parachutist has to be dropped for such a purpose as taking a package or message to earth.

The communication conveying all the details and drawings of my Cabin Parachute inventions for aeroplanes and airships sent to Air Vice-Marshal Sir Edward Ellington has never been discussed as to its technical merits by the Air Ministry. A formal acknowledgment of the communication and drawings was received and nothing else; but as my British, Foreign and Colonial Patents have been taken out in respect of these inventions, this letter to Sir Edward Ellington, with all its accompaniments, is now available for investigation by responsible authorities who may wish to see and understand what the proposals really mean.

While £60,000 to £70,000 has been spent by the Air Ministry in developing the Brennan helicopter during these three years many people think that such a sum would have been more usefully spent in the service of civil aviation in developing the Cabin Parachute. The Air Ministry are always busy babbling about "Safety in the Air"; but they give not the faintest encouragement or exhibit the slightest interest in aerial life-saving appliances. But I put the issue squarely before this Conference! The Air Ministry have got to come to a clear-cut decision and should announce it before the close of the Conference. Either they must declare that the time has come to begin the experimental work for developing aerial life-saving appliances for the big machines, and will push ahead with it, or they must state clearly that they do not intend to supply the big machines with parachute apparatus of any kind. If they have no means of forming an opinion upon the subject, and have now no parachute experts with practical experience of parachutes within the Ministry to advise them, let them say so and it may be possible for them to find this expert advice outside of the Ministry.

At the beginning of civil aviation the Air Ministry in August, 1919, issued rules which made obligatory the carrying of parachutes for all persons for whom accommodation is provided, including crew. The carrying companies and aeroplane builders then raised objections to bearing the first cost of fitting safety appliances to aeroplanes, to the cost of the extra petrol burned by the additional weight of parachutes; and to the diminution of paying cargo space within the fuselage by the bulk required for parachutes. For these economic reasons the builders and carrying companies were lined up, shoulder to shoulder against adopting the only possible means of providing for the safety of air passengers in the event of fire, breakage, or loss of control high up in the air.

The objections of the aeroplane builders and carrying companies could have been met if Government had taken upon its shoulders the onus of bearing the extra cost caused by the carrying of parachutes, which, although possibly crude and ineffective at the beginning, would quickly have developed on lines in accordance with the needs of all descriptions of passengers, young and old. Such a subsidy for increasing safety in the air would have been passed without the least objection from any member of Parliament.

The above is the position to-day. There is no subsidy for safety; and it results that the carrying companies to the Continent are potentially less concerned with the safety of their passengers than with that of their machines. True, they issue insurance tickets in the usual way, but it does not concern them whether their passengers purchase these tickets or not. What they are actively

Mr. Calthrop.

concerned in is the insurance of their machines. Assuming the average first cost of each six-seater machine to be £6,000 the insurance they pay per annum is about one-third of the value of the machine, or £2,000. As the passengers look after their own insurance the companies hold themselves in no way responsible for their safety beyond what is obligatory under the existing law, and consequently they are not concerned with any invention which in every eventuality may materially increase the safety of their passengers unless they are compelled to provide it by law.

The loss of the P.O. S.S. "Egypt" and the enormous sensation it caused evinced the lively interest of the public in matters relating to life-saving at sea; but yet not a single writer in the press appeared to recognise the relativity of this catastrophe to the companion problem of life-saving in the air. I ask the Conference to declare whether the carrying of aerial life-saving equipment is not of equal, or even greater, importance to the passengers and crews of great air-liners. Yet the question is banned alike by the Air Ministry, aeroplane builders, air carrying companies, and, strangely enough, by the insurance authorities themselves.

At the last Air Conference in February, one of the official speakers regarded a collision in the air as an inconceivable accident, since, in his opinion, the chances were many millions to one against it. Since this valuable utterance was voiced about a dozen of these inconceivable accidents have actually happened in various parts of the world, that on the Paris route being the most tragic. But it is these many millions to one- chances that sometimes do actually materialise. Until a few weeks ago no one would have believed that it could be possible for a golf ball bounding at the end of a long stroke to come to rest on the spear point of a vertical slat in a chestnut fence. But it happened. Two golf balls and two shells have met in the air. Ten million to one against chances do not wait to occur at the end of the ten million run, but can happen anywhere in it, even at the beginning of the first thousand. Fortunately, fire in the air has not yet occurred on any big air-liner carrying a large number of passengers, and crashing with its saloon filled with charred corpses; but there is no kind of certainty that it will never occur, or that it will not occur soon. Is it not better to provide against such a contingency before it happens than after it has happened? The law of the Cosmos is—What Can Be Will Be—sooner or later, and this catastrophe will happen just as soon as the conditioning factors are joined—say, a lady's leaking bottle of petrol for her hair, and the furtive dropped cigarette.

The carrying companies have got to realise this, whether they like it or not, that if such a catastrophe does occur the horror of it will be so great that the passenger business of the carrying companies will be absolutely stopped until aerial life-saving appliances are carried. Moreover, as was the case with the passengers of the "Egypt," claims would be made by the relatives of dead passengers which the carrying companies could not resist.

One thing more; on the 11th December last the press received a curious telegram from Moscow, as follows:—

NEWEST AIR THRILL.

PARACHUTE PLAN TO LAND PASSENGERS FROM EXPRESS PLANES.

> "Aerial voyagers are now to be given an entirely new 'thrill.'
>
> On the great 'Eastern airway.' to be continued on beyond Moscow, till it penetrates thousands of miles to the Pacific Ocean, the German-Russian Engineers are considering a new plan to avoid the delays which would be caused by the 'air expresses' having to descend constantly.
>
> The solution now suggested is the use of a parachute-borne, detachable compartment, in which passengers desiring to alight en route would be wafted to earth."

This Conference will agree that there is no mental terpidity amongst the best brains of Russian and German air designers, and if they succeed, as they will, in utilising both types of Cabin parachutes, the air authorities in this country will be compelled to devote prompt attention to producing the like.]

The CHAIRMAN: Gentlemen, our time is almost exhausted, and if those who have not been able to make speeches will put any remarks they wish to offer in writing, or any notes they may have, and send them to General Brancker, we will do what we can to satisfy them. I shall now call upon Commander Burney, who wishes to reply to one or two remarks which have been made about his paper.

Commander C. DENNIS BURNEY, C.M.G., M.P.: Your Grace, my Lords and Gentlemen, I ought not to take up your time in replying to the various criticisms which have been made as I think many of them have cancelled each other out. But there was one point made by Lord Gorell which I feel that I must answer. It was a suggestion—I do not think it was anything more—that the method by which I presented my paper rather raised the old controversy and friction between two Departments. Nothing was further from my thoughts. I had, however, as I tried to make clear in my paper, to treat the matter from the practical point of view, and from the practical point of view the difficulty is to get the money. That was the point I had to meet. Sir Alan Anderson put it very clearly and explained my difficulty in getting that money. That was due to the policy which the Government had pursued. They had spent 40,000,000*l*. on this device, and they could find no better use, after their expenditure, than to leave the results of it to rot in the sheds. The City of London is rather inquisitive when it come to financing any operation and would, therefore, require an answer as to the Government policy. One would do what one could to provide that answer, but their reply must necessarily: be "This matter is so speculative that we

cannot undertake it, if the policy of the Government is to be as we know it to have been."

As I tried to explain in my paper, I had to find a method of getting over that difficulty. I, therefore, analysed the situation as clearly as I could. I had to look to some Department who had money to spend, and a Department to whom I could go and say: "Here is a method by which you can economise." The Air Ministry had no money for airships at all. They said so, and they closed them down. Therefore, it was quite useless to go to the Air Ministry. The Admiralty was spending at the rate of 60,000,000*l.* a year. They are the Department which to-day are responsible for the safety of our great ocean trade routes; and so long as they are responsible for the safety of our great ocean trade routes, they must be responsible for the control and for the operation of whatever mechanical devices operate over those trade routes, whether above the water, on the water, or under the water. When a Ministry of Defence is set up the responsibilities as between the Departments will, no doubt, be altered; but we have to face facts as they are to-day, and the facts are that the Admiralty is responsible for the safety of the ocean trade routes. Therefore, I had to go to that Department as being the only Department which could treat with a cheaper method than now exists of protecting those ocean trade routes. That is why I did not mention the Air Ministry.

I went to the Air Ministry to start with, and I was in negotiation with them for months; but their reply was rather what General Seely said: "We have not got the money. We think it would be better to spend it on heavier-than-air craft, and therefore, much against our will, we have closed down the lighter-than-air craft." I do not think that anybody could accuse me of endeavouring to foster prejudices between the various Departments for taking the line of action that was taken. It was taken from the practical point of view of finding a Department which would get that *quid pro quo* which was necessary to counterbalance the risk of financing an operation of this character.

Commander Burney.

Major-General Sir W. S. Brancker, Director of Civil Aviation, Air Ministry: Your Grace and Gentlemen, I asked those who were present yesterday for criticisms, and the result is that I have received what Admiral Mark Kerr described as a shower of bouquets which, honestly, I feel that I do not deserve, but which, quite frankly, make me very happy. I can only deal with the small points which have arisen in the papers read yesterday and the discussion to-day, because, naturally, I cannot branch out into policy; that is impossible at the present time, and I hope that, as a result of this Conference, Government policy will be considerably affected. First, Mr. Fairey's paper, which was read yesterday afternoon, to my mind harped rather too much on engine failure. I had claimed in that connection that you can make an engine reliable, and I still think so. Mr. Fairey suggested that in, I think it was, twenty-four hours there were no less than twenty ships drifting about the ocean and out of control. The first object of my Department is to demand a standard of efficiency which will prevent that sort of thing happening. I think Sir Alan Anderson will agree that the Orient liners do not drift about out of control. I honestly think that we can keep an engine or, what is more important, its installation, absolutely reliable so long as the thing is properly looked after.

Through pressure of time I am afraid that I did not mention marine aircraft, though I certainly intended to do so. Actually we are starting a service to fly, in a few months' time, between Southampton, Cherbourg and the Channel Islands with the express purpose of gathering data about the flying boat and the seaplane; Mr. Fairey's paper was extremely interesting, and it bears out the theory I have always had in my mind, that up to a certain point, except in very exceptional geographical conditions, the flying boat and the seaplane cannot compete with the aeroplane. But when you come to the real big heavier-than-air machine that is going to compete with the airship in cross-Atlantic work, then, I believe, the flying boat has an enormous future; but it must be very big; it must have perhaps three thousand H.P.; it must be able to lay out at anchor and not everlastingly want to get into the sheds. It is a little bit far off in the future, I am afraid, but we have an experimental machine under order now which is tending in that direction.

Turning now to the discussion this morning, Mr. Holt Thomas's criticisms were chiefly directed to the policy and big questions, and I would like to say at once that I think we ought to give him credit for several things. He was the first man really to initiate the idea of a big national company, which he did in 1919. He also initiated the idea of the International Air Traffic Association, of which Jonkheer van Heemstede is the Secretary-General. That Association was intended to supplement the International Convention for Air Navigation, a purely Government concern, by a commercial association which would enable commercial companies to co-operate with one another right through Europe. In addition, we must, I think, give him credit for having given the incentive, last year, which led to the creation of the Civil Aviation Advisory Board.

In reference to the Paris route, I am afraid I may have been misunderstood yesterday when I said that Paris was no good. What I meant was that the limited route from London to Paris was a very bad example of air transport because it gave very few advantages; but it is obvious, of course, that Paris is on the highway to the South, and what is, perhaps, the most comfortable route to the East *via* Italy, Athens and Alexandretta. As to whether a route going only as far as Paris is a commercial, proposition, I rather doubt it, because we have had a Paris service running now for three years and yet the public do not use it nearly as much as they ought

to do. Mr. Holt Thomas took as an illustration the sending of my speech to Paris over the wire and by aeroplane, and contrasted the cost. I doubt whether my speech is worth sending over to Paris at that speed, and unfortunately there are very few other things which are worth sending; but aerial transport does do things which you cannot do in any other way. Personally, I have been dancing in London at two o'clock in the morning and have presided in Paris at an international meeting of some sort at ten o'clock the same morning, and you cannot do that in any other way. Unfortunately, the general public does not seem to want to do that sort of thing.

It is volume of traffic that we want. Unfortunately, we do not seem to get the volume of traffic between London and Paris that we ought to get to Switzerland, Greece and Italy. I think that the longer route will come, and then, of course, the London–Paris route will be a unit in a very important through route. With reference to the carriage of passengers and goods, I alluded to passengers rather than goods yesterday because the passenger is a very easy unit to deal with in argument. But it does not mean that I am in any way depressed as regards the outlook of carrying goods by aeroplane; in fact, as was pointed out, the Paris service looks very promising in that direction, and as we go further I think a lot of valuable perishable goods will use the air more and more. The same is true of newspapers. Lord Gorell and Admiral Mark Kerr also mentioned that point. The trouble to-day, as I think I indicated to you before, is that we have not the volume of traffic, and we cannot get the volume of traffic until we get safety and reliability; and companies, without Government assistance, cannot afford to run through routes until they have got the volume of traffic; so that we are rather in a vicious circle, with the result to-day that reliability is not established and safety is not established in the public mind, although we are trying to prove it to the the public. Therefore the volume of traffic is not coming along. The passenger traffic actually seems to have exercised more courage and initiative than the goods, and, up to date, passengers have been the staple support of air transport.

I do not agree with the speaker who said that because other means of transport (excepting the motor-car) do not pay when confined to the carriage of passengers, therefore passengers would not pay in air transport. Aviation is going to give speedy transport in return for a certain increase in cost, at any rate for some time to come. Later on, I believe, it will be able to do it without an increase of cost. You are confined to any load which will pay for speed. The passenger is essentially the "load" who will pay for speed; hence the success of the motor-car and the reason that it pays.

I think that Admiral Mark Kerr also made it clear that one of our jobs is to educate our financiers because he proved that there was a good deal of money in air transport in America; yet no one has attempted to educate them here. Lord Gorell and Captain Alfred Instone criticised my statement that the present scheme is a temporary one. Well, it is a temporary scheme because the sum of 600,000*l.*, which was voted in 1921 to cover financial assistance to cross-Channel services, is coming to an end, and by the 1st April, 1924, we shall very nearly be at the end of it. Therefore it is necessary for the Government policy to be formulated, before one can say that anything is more than temporary. There is no one who realises more than I do—and I think the whole of the Air Ministry realise it—that the great difficulty of the companies at present is that they have no sort of guarantee for the future. They cannot build up to-day because there is no certainty about the future. You cannot be expected to spend a copper on new aircraft, on research, on experiments and other things which have cropped up during these discussions if you are faced with the fact that at present Government policy is not settled or formulated.

Then Lord Gorell alluded to two very important points which I was forced to omit from my paper yesterday owing to the shortage of time, namely, the comfort of passengers and the diminution of noise, the latter of which General Seely also emphasied. I quite agree, and that is one of the things we are worrying about. The elimination of noise is a most difficult question. The prevention of air sickness is another most difficult question. But outside of those two things, in regard to heating, ventilation and comfortable seats, and so on, the problems, I think, are probably easy. The provision of heating, ventilation and comfort and the elimination of noise will go a long way, I think, towards preventing air sickness. Actually we have a large two-engine machine on order with Messrs. Vickers now in which we are going to put all possible experiments towards the comfort of passengers, and it is up to Messrs. Vickers to help us in every way they can. I think they have a fairly free hand in reference to any ideas they have got in dealing with this very important question.

Then Mr. Handley-Page accentuated the fact that the southern route *viâ* Paris was an important one. I quite agree with him in that. I might also say that he had the choice of the three routes, and he took Paris as being the one which was most likely to be profitable; so that it is up to him to prove that it is so. He referred to a future life, and I think if the worst comes to the worst in this life he will certainly get a halo in the next. I would like to compliment him on the fact of his extraordinary reliability and safety during the past two years. I believe I am right in saying that it is for his company that the insurance companies have very considerably reduced their premiums, as a result of good operational work

General Seely's theory about the noise was extremely interesting to me. I had never before thought that noise affected the pilot. The pilot's brain is a very important item. I have become more and more anxious lately about the number of gadgets we call upon a pilot to operate, and the things we ask him

to do. It seems to me that in the very near future one must give him an assistant pilot to help him to do some of those things. If we can help him also by cutting down the noise it will be an additional factor towards his efficiency. Mr. Ashbolt and Sir Alan Anderson both dealt with matters of policy with which I am not at liberty to deal at present. Captain Instone also referred to a good deal of big policy and commented on the scheme of subsidies being of a temporary nature. The same answer holds good in his case. He also brought up a very important question which Sir Henry White-Smith afterwards emphasized, and that is the production of the commercial aeroplane. We quite realise that air transport companies are not to-day in the position in which they can invest money in research and experiment. Therefore, as I intimated yesterday, we are going to call for tenders for three air transport machines. You can criticise them if you like. I took the advice of a good many other people and then drew up the main lines of these machines as being what I thought would be required in certain conditions. The first is a machine for European work, across the Channel and so on, which will be more economical to run than existing types. The second machine is a machine which would be useful on the route to India, where we might have to fly five hundred miles, perhaps against a strong wind, and there are certain other things which are peculiar to the East. And the third machine, as I indicated yesterday, is one which can fly from London to our nearest red spot in the Mediterranean—Malta. That, of course, is not what you would call a good commercial proposition, although I think that it would be possible from an aeronautical point of view. The real point is that, having done that, you can cut down your fuel consumption as much as you like and you have the real big machine which several people have advocated.

The most important question that was asked is, perhaps, what we should do if Germany would not join the Convention. I think that perhaps I was not quite clear in my statement on this matter yesterday. What I said was that if Germany joined the International Convention our troubles as regards Cologne would be eliminated. As soon as the Amendment to Article 5 of the Air Convention is ratified we can make a separate agreement with Germany and fly over all parts of Germany outside the occupied area. The occupied area at present is such a tangled problem that I cannot deal with it, and I do not think anyone knows what is going to happen.

Then, I quite anticipated that somebody would take up the question of the small aeroplane, and I have not been disappointed. My point is just this, that when you have a very small volume of traffic it seems that it must be most economical to use a small unit which is easily handled and to which, if you get more unexpected traffic, you can merely add another unit. Captain Instone talked about picking up and setting down passengers *en route*. If you think of Central Africa and of Persia, and that desert on the way from Cairo to Baghdad, you will realise that there are very few passengers whom you are going to pick up and set down *en route*. That is the trouble. It will be all right for Europe, and I am all for seeing the machines grow bigger on those European routes. But when you get to an attenuated part of the route—those bits between Egypt and India, we will say, or between Angora and India, and the bit between Khartoum and Cape Town—you cannot count on any sort of volume of traffic for some considerable time to come. Therefore, I think it is better in every way to standardise on the small machine in the first few years,

I am grateful to Captain Instone for making two very useful remarks regarding propaganda: first of all, about post-marking letters, which never entered my head before, and secondly, making use of the Lord Mayor's Show. I will also support him in his contention that the press have done great things for aviation in this country. They have shown imagination. They have devoted a lot of space to it, and have helped us enormously, particularly, I think, about a year ago.

Then Admiral Mark Kerr brought forward a very important question—the use of parachutes. Our Chairman, the Duke of Sutherland, actually had a letter from Mr. Calthrop this morning enclosing a paper which he was very sorry he was too ill to read himself, and expressing the hope that it might be read by somebody else. He said that he noticed that no mention had been made of parachutes. Unfortunately, we have not had time to read his paper, but it will be included, no doubt, in the final report of this Conference. Generally speaking, he complains that parachutes have been completely neglected. To some extent they have. But their use is chiefly military, and that part of the question I shall not touch upon, as Admiral Mark Kerr has already done so. When we come to the civil side of things I have racked my brain to discover just what good parachutes would be to us. If you take the general run of accidents which have occurred since the end of the war, it is very difficult to find one, to an aeroplane at all events, in which a parachute would have been of any use at all, and to-day, as we are having to deal with cabin machines, it makes it still more impossible to use a parachute for each individual in a machine. There is a proposal on foot to have a huge parachute which will take the pilot and his cockpit and the whole of the cabin. That is a possibility, but it will cost a great deal of money to try it out.

Again, when you look into the possible accidents I do not quite see where parachutes are to help you except in case of collision or fire in the air. As far as British aviation goes I hope we have finished with fire in the air in commercial machines. Collision in the air is the thing that will be a danger in the future. I look upon it as the only danger; but we have not got sufficient aircraft in the air today to calculate much on collisions, and I do not think we have yet reached the point at which we would be justified in spending a large sum of money in evolving a parachute

Sir Sefton Brancker.

which will take a whole cabin of sixteen or twenty people. The only use for the parachute in commercial aviation that I can think of is that in case of collision the whole cabin and the crew can be brought down on one big parachute. That is the problem which I believe Mr. Calthrop is trying to work out at present.

Various people have talked about the map here, and I think I must plead guilty to a little subtlety. You may have noticed yesterday that I made very little comment about the map, but I hoped the fact would soak into your minds without my saying anything about it—that we have a very long way to catch up and that we have a very great heritage in Australia, at one end of the globe, and our own country at the other, and must quicken communication between the two. That, I thought, would sink in mentally without my having to say anything about it at all.

Finally, gentlemen, I particularly avoided yesterday talking about air transport in relation to military aviation and its value as a reserve. It is a very controversial question, and I have my own opinions about it. I tried to avoid it and to confine myself to pointing out the enormous commercial advantages of air transport. I think that is really the best spirit in which to approach the question of air transport. Let us leave the military side of it alone; that will come automatically. Let us try to think out the commercial benefits that will come from air transport. I do not know that I am voicing the opinion of the Government here, but I entirely agree with the remark made by Admiral Mark Kerr as to the value of the urge of fear in getting things done.

The CHAIRMAN: Gentlemen, it is my duty now to say a few words in winding up this interesting discussion. I should like to assure Admiral Mark Kerr that, as regards the question of parachutes for military machines, Sir Geoffrey Salmond proposes to answer that this afternoon in the course of his reply on his own paper, and I hope Admiral Mark Kerr will be able to find time to be present in order to hear what Sir Geoffrey has to say. Although I have only been at it a short time—namely, three months—and although I started in the same way as the Secretary of State for Air, as quite new to aviation, I am learning a little, and I am more than a little interested. I can assure you that anything I can do to further aviation will be done. I find it extremely interesting, and I shall find it more and more interesting, no doubt, as time goes on. I think we are all agreed that the future of civil aviation depends to a great extent on the raising of sufficient capital to make it a commercial success by means of an agreement for a considerable period of years. That is absolutely essential for the purpose. I shall say no more now, because I do not want it to be thought that Commander Burney, in the interesting paper he read, referred to Lord Gorell, and myself, in the quick change of Government, when he said that you can change a complete gasbag in a very short time.

AFTERNOON SESSION.

Sir WILLIAM JOYNSON-HICKS, Bt., M.P., in the Chair.

The CHAIRMAN: Gentlemen, I will call upon the Duke of Sutherland to read a letter from the Secretary of State.

The DUKE OF SUTHERLAND: The Secretary of State writes to me asking me to read this letter to the Air Conference.

> As I told you yesterday, I have unfortunately a Cabinet Committee meeting which I must attend this afternoon. I am therefore prevented from being present at the last session of the Air Conference. Will you be so kind as to express my regret to those present, and my thanks to them for the valuable help they have given to us by their discussions on air questions. I shall not fail to read the verbatim report of the speeches that have been made, and whilst I cannot undertake to agree with every suggestion, I can assure the speakers that I shall give full weight and serious consideration to their remarks. So long as I am Secretary of State I shall welcome the free discussion of air questions, and neither resent criticism nor repudiate suggestions.—Yours sincerely, (Sgd.) Samuel Hoare.

The CHAIRMAN: I do not know whether it is the duty of the Chairman on these occasions to make any remarks, because this is the first time that I have presided at the Air Conference. I should like, however, to express my thanks to the Secretary of State, my friend Sir Samuel Hoare, for having given me the opportunity of occupying this chair this afternoon. All of you know the very great interest that I have taken in aeronautics for the last ten or twelve years, and though my activities now lie in different directions than those of aeronautics, I still follow everything that is being done and said in the aviation world with the same interest with which I used to follow it of old.

This afternoon I understand that you are going to discuss the outcome of the technical papers that were read yesterday afternoon, particularly those by Sir Geoffrey Salmond and Mr. Fairey. I have read them both myself. They are, I think, really the most important papers that can be read at any Conference like this because, after all, the prosperity of the air service depends entirely on research. All through the war, when our air service developed at such a wonderful rate, it was owing to research that those developments were made possible. If you realise the great work that was done, for instance, at the National Physical Laboratory, and how the tests that were made there on quite small models proved when they were tried in practice the complete accuracy of the tests made in the laboratory, I think it is now fair to assume from the research point of view that tests on a small scale in the laboratory can give us completely accurate information as to what aeroplanes will do when they are carried out on the large scale in what we may call "real life."

If I may refer for one moment to the remark in Sir Samuel Hoare's letter that he does not resent criticism, I am not going to criticise in any degree whatever, but I should like to appeal to the Duke, who is here, and through him to the Secretary of State and the Cabinet, that however much it may be necessary to economise—and I realise the financial position of the country is such that we cannot have at the moment the great air service which some of us would like to see—it is sincerely to be hoped that no economy will be effected at the expense of research. We must be in the van of the whole world in regard to this question of research. We must keep our improvements not merely abreast of the improvements in other countries, but I should like to see them far ahead.

Sir Geoffrey Salmond's paper has dealt with several points where improvements have taken place and are taking place. Who would have thought in the early part of the war, for instance, of metal propellers, and all-metal aeroplanes? Yet I think it is not merely that they are possible to-day but they are an absolute certainty. And when you have got your all-metal aeroplanes you will have saved pilots—as I know personally from having spoken to many of them before, during and after the war—from one of the greatest terrors of a pilot's life, namely, the possibility of fire while in the air.

These things are what I may call mere improvements incidental to the ordinary carrying out of aviation work. But what has taken place in the last ten years will, I am quite sure, take place in the next ten years. Those of us who prophesy—and I can see looking round me here the faces of several who were foolish enough ten years ago to prophesy in conjunction with myself—were content to be called fools in those days, when we either in the House of Commons or in the public press prophesied air speeds of 200 miles per hour and heights of 15,000 to 20,000 feet. We were laughed at both in the House of Commons and in the press. Now you know that those prophecies all came true, and came true even more quickly, perhaps, than some of the prophets themselves realised would be the case. The real difficulty about aviation prophecy has been to get the mind of any sane man to prophesy fast enough, so quickly have been the developments of aviation in the last ten years. When you know now that heights of 30,000 feet, and speeds of from 250 to 300 miles per hour, are well within the possibilities at the present time, who is going to set a limit to the progress of aviation in the next ten years? I certainly am not. I am not going to suggest that we have reached the limit of improvements of our engines, that our constructors have reached the limit of improvements, or that in the material that we use we have attained finality in any way whatever. I myself am convinced that those improvements will be as great in the next ten years as they have been in the past.

But there is one direction where I should like constructors and inventors to consider the possibilities, and that is in regard to the electrical side of aviation. We now have wireless telephony; we now find it possible to communicate verbally with machines in the air. But that is not the extent of radio-discovery to-day. The men who are to-day making the discoveries in radio-telephony, and what not, are appalled themselves month by month at the discoveries they are making. There is no doubt whatever in my mind that within a very few years it will be perfectly possible to listen to the conversation of anybody in a private room even though there be no receiver in that room. That I think is one of the inventions which is well within the possibility of immediate development. It is an added terror to life, I know, but I think we are in for an age of terrific discoveries in this direction.

Sir W. Joynson-Hicks.

Now, apply that to aeronautics. It will not be very many years before in extreme cases the pilot will be a thing of the past, your aeroplanes will be directed electrically. Think of the possibilities of that. Those of you who discussed the possibilities of bombs on London in the year 1912 and were laughed at for your pains, think of the possibilities, to my mind the certainties—I am making another prophecy, and perhaps you will think I am not sane in doing it—certainties of large fleets of aeroplanes in the next war carrying high explosive bombs far more terrible than any we have had in the last war, and possibly containing something worse than mere explosives, travelling without any pilots, during the night, perfectly silent, both as to their propellers and their engines, directed electrically, and carrying death to any town that it may be desired to destroy. That is no more extreme a prophecy than the ones you made ten years ago, and of which you have seen the fulfilment.

In this afternoon's discussion I know you are going to discuss matters of detail, but I should like those of you who are engaged in research, particularly those of you who are engaged on the electrical side of research, I will not say to prophesy, because perhaps it is more dangerous for you than for myself to prophesy, but to consider in the near future what enormous strides are certain to be made in electro-radio science, and apply your minds to it so that if that dreadful time should ever come again when there is another European war, Great Britain will be in the van instead of behind-hand in aeronautical discovery.

I have had the names of several gentlemen sent up to me who are prepared to take part in the discussion this afternoon. In the first place two gentlemen have been asked by your Air Council to lead off: Professor Bairstow, who will speak on Sir Geoffrey Salmond's paper, and Commander Bird, of the Supermarine Company, who will speak on Mr. Fairey's paper. I will call upon Professor Bairstow now.

Professor L. BAIRSTOW, C.B.E., F.R.S., F.R.Ae.S.: Mr. Chairman and Gentlemen: In his opening remarks yesterday Sir Geoffrey Salmond found it advisable to point out to the Conference that there is no limit to the view of research, or, as he put it, that research has no horizon. This is true not only in aeronautics, but in all branches of scientific research;

but in spite of that fact, in spite of the breadth of view, research has its milestones and has its landmarks. The particular landmark under survey at the moment—whether it will prove to be a hill or mountain we cannot tell until we get a little nearer—is that particular one which marks the subject of safety and reliability in aircraft. Where restlessness is a primary attribute as in the research worker, it is inevitable that considerable attention should be given to the means of getting from point to point, and it is a pleasure at this Conference to be able to agree that the situation is improving, thanks mainly to the efforts of Sir Geoffrey Salmond. Our weak point still lies in the facilities for full scale research, and as a remedy towards this we have Sir Geoffrey Salmond's assurance yesterday that the Air Ministry is prepared to consider the making of special aeroplanes for the study of stability and control. It has done this at the request of the Aeronautical Research Committee, which is giving a great amount of attention to the subject. For the first time, I believe, in the history of aeronautical research we can look forward to having an aeroplane in which the spare load, the load which in a commercial craft is used for carrying passengers and goods, can be used for experimental instruments, for adding to the strength of the structure, and adding special parts solely with an idea to the efficiency of the experiments carried out. I hope later to indicate some of the important results which may be expected from such facilities.

In addition, the contact between the Aeronautical Research Committee and the Air Ministry has during the past year been made much closer by an arrangement which allows the Secretary of the Aeronautical Research Committee to spend part of his time in the Air Ministry in direct contact with the Air Member for Supply and Research.

Returning to a general survey of the subject, I may perhaps emphasize some remarks which fell from our Chairman a moment ago. The British arrangements for model testing are particularly complete. In bulk we are very much better placed than we were in the early days, and for type, that is, arrangements for special conditions of working, we are also in a generally satisfactory position. The cost is small, somewhere about £30,000 all told, and the value of the work is immense. To take an example: In connection with seaplanes we find, for instance, that tests on the Froude tank at the National Physical Laboratory have indicated three instances in which certain designs of seaplane hull failed to function, and as a consequence of this knowledge from the model side considerable expense on full scale construction has been avoided. Our knowledge of the relation between model and full scale is now such that the model can be relied upon to give a very good first idea as to what would happen on the full scale. We know of no outstanding discrepancies of great magnitude, for of such differences as do exist or are suspected—it is mainly suspicion at the moment rather than accurate knowledge—between model and full scale, some are represented by such quantities as the effect of wind and wave on the seaworthiness of seacraft.

I wish again to suggest that for large aircraft it is a great economy to start design by a knowledge of a model, and then I wish to add that we have reached a stage where more complete testing on the full scale is desirable, in fact essential, for further progress.

Our subject is almost wholly experimental. We can deal with very little of it from first principles, and where the field is so immense a great deal of ground is eliminated from the problem if we can say roughly what is happening on the full scale. We can then concentrate on the details in the limited field. The object of research, of course, and all the steps up to production, is the provision of efficient aircraft suitable for use in commerce and for the defence of the country.

The test of the aircraft is in its use. As a member of the Accidents Investigation Sub-Committee under the Air Ministry, I have had an opportunity of seeing the results from a particularly interesting standpoint. It is one, of course, which naturally rather emphasizes the failures, but from the general mass of imperfect data one fact stands out clearly, and that is the serious consequences to an aircraft of a trivial error; not only in the case of materials, as pointed out by Sir Geoffrey Salmond yesterday, but in all the other branches of aeronautics, it is necessary to proceed to a degree of refinement not required in the older branches of engineering. For instance, the failure of the jet of a carburettor (which is quite a small part) to function properly in a motor-car simply means a stoppage and a little attention; but in an aircraft it may mean stoppage of the engine in the air, and then several other consequences. Naturally a pilot who has to make a forced landing on suitable ground would choose to do so at the lowest flying speed at which he can maintain control. If there are obstacles in the way and his run is expected to be too great, he may overdo it, and the consequences of an error of judgment in that sense are always the same, quite regular, quite well known, and perhaps happen in 80 per cent. of air crashes. The machine puts one wing down and finally puts its nose down, and hits the earth at a higher velocity than had it been flying steadily.

Now, the consideration of these problems leads to several lines of inquiry. The first obvious course is largely a palliative. One would look for a better carburettor jet, or one would, as often is the case, attempt to remove the causes which allow dirt to get into the carburettor, rubber connections being a serious cause of trouble in that respect. If you look a little further, you will find that is only a superficial remedy. A more serious cause of difficulty is the fact that some types of aero engines are so extremely sensitive to the mixture with which they have to work, and one is thus led to an inquiry into suitable fuels for aircraft engines. We know from motor-car practice as well as from aero-engine practice that one of the serious limitations is detonation, and one of the sub-committees of the Aeronautical Research Committee has

in hand a research into detonation and its causes. If we take an analogy from medical research—an analogy which is helped by the recently-announced discovery of the influenza microbe—and apply it to aeronautics, we should take the order of research as firstly to find the cause, and then the remedy, the latter being often a relatively simple matter. Until the cause is found one may experiment many times without any effect at all.

Another line of inquiry was mentioned in the paper read by the Air Member for Supply and Research yesterday, and occurred under the paragraph: "It has been possible to glide an aeroplane steadily under good control at an angle of incidence of 40°." That represents a matter which was conjecture a year ago, but which is now accomplished fact. And on the strength of that the Aeronautical Research Committee conceive hopes of making an aeroplane controllable even when stalled, that is to say, when flying at low speeds there is hope that the pilot can be given enough control to keep his machine on an even keel, so that the shocks are taken by the under-carriage intended for them, and not by other parts of the aeroplane.

Those are only some of the lines of investigation which suggest themselves. Before I go completely from the subject of control I would like to mention that there is one rather dark spot in the prosecution of aeronautical research. An officer of the Air Force who has taken a distinguished part in flying experiments has been posted elsewhere. It is the general opinion of those qualified to judge that further research in that direction will suffer by his going, though, of course, it is realised that someone else will benefit by the change. The seriousness, I think, is not so much in the individual case as in the reason for his going. We understand that he can only remain where he is and continue his research work by the sacrifice of his career in the Royal Air Force. Part of my daily work consists in the passing on of research knowledge to Air Force officers. Pupils come to me at the Imperial College of Science and Technology, and I find one of the difficulties is to see a sufficiently bright outlook for the members of the Air Force who retain any addiction to technical qualifications. I would like to point out that in another Government Department where this difficulty has also appeared, a special provision is being made for careers for technical officers whilst still remaining technical and whilst still making use of training only obtained after many years of arduous work.

I should like also to express my appreciation of the facilities which were asked for last year for designers to see more of their machines before they were taken over by the Air Ministry. I understand from what was said yesterday that some $3\frac{1}{2}$ hours of flying time is now allowed to makers before the machine is handed over to the Air Ministry. It is not a very long time, but it is an improvement, and I should welcome any further extension in this direction. I am quite credibly informed that designers are now willing to undertake responsibility for the good running and good flying qualities of the aeroplanes, with financial responsibility, and that they are doing so for the civil air services. In some such direction again have we much to look for.

In conclusion I should desire to repeat my view that the future is hopeful, and that experiment and research is now tending upwards, and we may hope shortly to be again in the position to give important assistance to the Air Ministry.

Squadron Commander J. Bird, R.N., Director of the Supermarine Aviation Works, Ltd.: Mr. Chairman and Gentlemen: I am afraid when I was asked by the secretary to speak this afternoon I did not quite appreciate that I was going to have the honour of opening the discussion on Mr. Fairey's paper. I have only made just a few short notes, which is probably quite a good thing as there are many here who are far better able than I am to discuss technical points.

I feel sure that everybody present will second me in congratulating Mr. Fairey on his most interesting paper, and on the extremely able and impartial way in which he has dealt with his subject. I should think that there is no more controversial subject in aeronautics at the present moment than the question of boats versus floats. While I quite agree that both types will always have their special uses, there are many who maintain that one type or the other is best for all purposes. To my mind the most important point brought forward in this paper is the lack of proper comparative tests under varying conditions carried out during the last few years. I am speaking, of course, of full scale tests. True the Air Ministry has during the last twelve months done much to try and rectify this want, but I would urge on the authorities how very important this is, and how much more could be done. It must be remembered that the seaplane has never had the same chance to develop as the aeroplane. What designers and constructors want is to see their products used and tried out under all possible conditions, and most important of all, to be told in full as soon as possible the results of such trials in so far, of course, as they are applicable to design and construction.

Perhaps it would not be out of place, whilst on this subject, to point out what an excellent opportunity occurs for finding out the kind of information required through the invitation of the Swedish Government for all nations to send machines to Gothenburg for the Exhibition which is to be held there during the summer of this year. I understand that France, Germany, Italy, Belgium, and other countries have already decided to send machines, but that the decision of Great Britain has not yet been reached. It is known that the Scandinavian countries will be placing orders for aircraft after the Exhibition, and if the Government can possibly see their way to send a composite squadron of various types, I suggest they would be achieving a threefold object by firstly, upholding British

aerial prestige, secondly, by doing a great service to the British aircraft industry, and thirdly, by gaining most valuable data as to the behaviour of the different types under identical conditions.

Turning to just a few detail points in Mr. Fairey's paper, I would first like to refer to his comparison of the advantages and disadvantages of the boat and float type. I am afraid I cannot agree with him as to the disadvantages of the boat type. With regard to the difficulty of the high centre of thrust, this has been quite got over during the last year, and even in such an extreme case as the Schneider Cup winner, this machine is stable under all conditions with engine on and off, and the engine throttle can be made to move quickly from shut to open, and vice versa, without causing any alteration in trim. The difficulty of beaching is, in my opinion, no greater with the boat than with the float type. The risk of total loss through damage to hull is, I consider, less. In most flying boats the steps are built on separately after the hull structure is completed, and these act as a double bottom which is divided up into a number of water-tight compartments. It does not matter how much the steps are damaged there is no fear of the machine being lost, whereas if the bottom of only one float of the float type is badly damaged the machine must inevitably turn turtle. Furthermore, it is a far simpler matter to fit bilge pumping gear to the double bottom and to the hull itself than to floats.

Under the heading of seaworthiness, I would like to point out that a different type of two-step hull is produced which is quite stable on the water, but owing to its small amount of stability is also controllable by the pilot at will by means of his air control.

Under the heading of handling, I quite agree with Mr. Fairey's remarks as to the present methods, but I do not agree with his suggestions as to the remedy. Most of the methods referred to are far too costly. The problem appears to me comparatively simple. All amphibians can, so to speak, look after themselves. Small seaplanes can either carry, or ship or unship during beaching and launching operations, small wheels such as suggested by Mr. Fairey, and to my mind the large seaplanes must be made to remain afloat and go into dry dock or on to hards in exactly the same way as ships do whenever under-water repairs or cleaning is necessary.

Again, I agree that many of the problems concern handling rather than the machines themselves, and I submit that the greatest possible attention should be given to the training of crews and station personnel in every branch of seamanship.

In conclusion, I should like just to make a very short reference to the question of engines. Up to date, engines are supplied to seaplanes identically the same as they are to aeroplanes, and the engine makers must give far more attention to what I may call as a general term "waterproofing," and to such points as the position of air-intakes, to stop the spray being sucked up into the carburettors.

Sir Richard T. Glazebrook, K.C.B., F.R.S., F.R.Ae.S., Zaharoff Professor of Aviation: Mr. Chairman and Gentlemen: I value very highly the opportunity of speaking here this afternoon, and particularly of being able to congratulate Sir Geoffrey Salmond warmly on the paper that he read yesterday. He described to us the long and important series of researches and work that has been going on under his favouring care during the past year, in all of which I think a very distinct advance has been made during that year.

I do not want to discuss more than one or two of them, and those quite briefly, but before I go to that point I should like again, as I have done before in this room, to call the attention of those present to the great importance of what I may style fundamental research in the principles that underlie all the advances that we are likely to make or can hope to make in aeronautical science. To quote the words of a Committee which reported on this subject some few years ago: "Research is the means by which advance in aeronautics is possible, and this is recognised by all interested in the progress of aeronautics." That, I think, has been very fully realised by every speaker at this Conference, and I believe it is felt to be proved by all present. But the research in particular in which I am interested, and which I wish to bring specially to the notice of those present, is that, as I have said, which concerns fundamental matters.

A paper was read before the Royal Aeronautical Society a few days ago by Mr. Baker, superintendent of the Froude tank at the National Physical Laboratory, and he dealt with recent advances in connection with seaplanes. He pointed out the need for further experiment and research of a fundamental nature, and he concluded with these words: "Research on such lines should not be deferred until the machines are here, but should be well in advance of present requirements and should be unrestricted in its general character." That is the kind of research for which I wish to plead, and I should like to ask, not that Sir Geoffrey Salmond should give us more opportunities for research of that kind—for I know he is quite ready to do that, and I need not ask that of him—but that those who are responsible for allocating funds for research purposes in the Ministry should realise that it is the fundamental matters of research that are of importance if we wish to progress, and that funds should be available for all such matters.

At the very pleasant gathering last night at which I had the pleasure of meeting you, Sir, you asked a question. You put to me and to the President of the Institution of Electrical Engineers this question: "Can you tell me what electricity is?" and our reply was that we could not. But though we could not tell you what electricity is, we could tell you much about the laws to which electricity is subject, about the forces which electricity brings into play, and generally about the energy of which electricity is the cause. Now I want to point out that our power to answer those questions—and similar questions may be asked with regard to

aeronautics—arises from the fundamental researches of Faraday, Maxwell, Kelvin, and Rayleigh, and such men, who worked at the real fundamentals of the subject and thought little about the applications to which they might be brought.

You, Sir, realised last night, I think, as we all did, what we owed to the advances of electricity, and we had in the room some illustration of those advances, especially wireless telegraphy and its importance in connection with our air work. The germ rom which all that work has sprung is contained in a paper of Professor Clerk Maxwell, written about 50 years ago, "On the equations of the electro-magnetic field," and from that piece of theoretical work the whole of our present knowledge of wireiess has come.

Now if I turn to aeronautical science I do not find a position of that kind. I find that in many of the fundamental matters we are profoundly ignorant. I have in my hand, it so happens, a notice of papers to be read at the Royal Society to-morrow. The first paper on the list is one by Professor Bairstow who has just spoken to us; its title is "The resistance of a cylinder moving in a viscous fluid." I have not had the pleasure of seeing that paper, but I understand from the abstract something of what it is about and what it contains, and I venture to say that if the statements contained in the short abstract which I possess are really confirmed, the work that has been thrown into that paper and the results that have been arrived at in that paper are of more importance to the real progress of aeronautics than very much of the research and of the work that has been discussed here during the past two days. It is work of that kind to which encouragement should be given. There is another paper by Mr. G. I. Taylor on "The motion of ellipsoids in a viscous fluid." Almost the same can be said about that paper. An airship in form is very much like an ellipsoid moving through the air, and it is the viscous properties of the air with which we are to no small extent concerned in our discussion of the problem. The solution of these two problems offers opportunities for great advance, and I want to bring that before the notice of the meeting in the hopes that for the promotion of work of that kind we may look to the kind support and help of the Ministry.

Professor Bairstow has referred—and he might have spent much more time over it —to one or two pieces of work done by the Aeronautical Research Committee, of which he is a distinguished member, and of which I have the honour to be the Chairman. In particular he mentioned the work on the control of an aeroplane at low speeds. That involves the whole problem of the stability of aircraft, a problem that was first atacked many years ago by Professor Bryan, and that was put into practical form first at the National Physical Laboratory by Professor Bairstow himself with the help of the Royal Aircraft Factory, and which so far as the longitudinal stability of an aircraft goes is now well understood, and can be, and is applied. But in order completely to determine the stability of a machine a number of quantities, known as "resistance derivatives" have to be determined, and the problem which has been worked out at the Laboratory during the last year and a half has been to determine those quantities on which the stability depends for the numerous cases that naturally arise. That problem has, I am glad to say, been successfully solved, and not merely successfully solved, but, as Professor Bairstow has told you, the results of the solution have been applied, and it is now known how you can secure proper control of an aeroplane at low speeds; and as he also has told you, and as Sir Geoffrey Salmond told us previously, arrangements are being made for constructing special aeroplanes in order to test some of the questions that have been raised. In that way we have advanced.

There are many other matters that I might allude to. Just let me mention one to which our attention was called by the very valuable address we had this morning from Sir Henry White-Smith. We all realise, I think, that the problem of the plans for securing commercial communications with India and other places situated at long distances from us is of the utmost importance, but as Sir Henry White-Smith pointed out, we know very little indeed of the proper aeroplane to select for that work, and a vast number of important questions arise in connection with it. As he said, the matter was referred by the Board on Civil Aviation to the Research Committee, and as the outcome of that reference certain recommendations were made which have, I understand, been included in the Report of the Civil Aviation Committee which will enable necessary experimental work to be done and necessary theoretical ideas to be developed, and will, I hope, in the end, save large sums of money and lead to successful results.

There is one other point I should like to mention, which perhaps is not so closely connected with Sir Geoffrey Salmond's paper as with the paper we had yesterday by Commander Burney. He told us that there were both financial and technical difficulties connected with the inauguration of the big airship service for which he is pleading, and he pointed out that without financial aid nothing could be done. I should like to ask if it is the view of those who are pressing for that service that their technical knowledge is now sufficient to enable them to go ahead? I think it will be found on inquiry that there are very many problems connected with the manufacture and with the working of a large airship which require most careful scientific and technical investigation. For instance, very little indeed is really known about the aerodynamic pressures to which a large airship is subject in the air, and there are quite a number of points in aerodynamics which it is absolutely necessary to investigate before a service of the kind indicated can really be started in a satisfactory manner. I trust that if the Government decide to go on with a scheme such as Commander Burney's

full opportunity will be given to complete in a satisfactory way the admirable work which was being done a few years ago by members of the staff of the National Physical Laboratory in connection with airship problems.*

Again, I should like to thank Sir Geoffrey Salmond for his paper, and for the work that he has done at the Air Ministry in the encouragement of research. I am sure, speaking as Chairman of the Research Committee, that the whole Committee appreciate that work, and we look to him with confidence for further help in the future.

Major F. M. Green, O.B.E., F.R.Ae.S., M.I.C.E.: Mr. Chairman and Gentlemen: There are very few things I want to say, but there are just one or two points in the admirable paper of Sir Geoffrey Salmond I should like to take up. I know in a paper of this sort it is very difficult to avoid taking a rather wide view of the subject, but there are just one or two points which I think are scarcely correct and if I may be allowed I should like to draw attention to them.

In the paper it is stated that in the total cost of flying the cost of fuel is more than half. That is scarcely correct, because if it were, it would only cost about 10*d.* a mile, or rather less, to fly an 8-passenger aeroplane, as the petrol consumption of such a machine comes to about 5*d.* a mile, whereas we know that the total cost is more nearly 4*s.* or 5*s.* a mile. I think, therefore, there is some mistake; it may be that I have misunderstood what is meant by "total running costs," but I think the matter needs some explanation, because even if we got our fuel for nothing at all it would still be a pretty expensive matter to run a service.

Another point which I think was a rather striking generalisation occurred in Commander Burney's paper. He made some statement which I failed to understand, to the effect that the life of an engine was inversely proportional to the temperature of the exhaust valve or the exhaust gases, I am not sure which. That is a very remarkable statement, and I do not think engineers ought to pass it unnoticed. Perhaps Commander Burney will tell us how he arrived at that rather remarkable result.

It has frequently been suggested that the use of gliders of a quarter or half size would be very much better than the use of what were perhaps rather curiously described as toy models. I do not think any disrespect was meant by the use of that term, but it seems to me that it will be very much more difficult to get at full scale results from gliders than by other means. To use a glider it is almost essential to have an up current, or else to have a peculiarly favourable place from which to push off your glider; the more direct method of using a ordinary power-driven aeroplane would seem the better one, and the methods which have been used so far appear to be very much cheaper and more practical.

With regard to wind channel models, we are, I believe, arriving at a stage when we can put more faith in them than prehaps some of the designers have been able to do in the past. The correlation between model work and full scale work is progressing favourably, and it seems to me we shall do much better if we stick to the lines we are working on than try to make experiments with gliders.

Finally, I should like to thank Sir Geoffrey Salmond very much for the very sympathetic way in which he deals with research. The only thing I should like to suggest is that if the results were made available to the designers a little more quickly they would be of very much greater value. I know that in scientific work nobody likes publishing results that have not been finally checked and proved and gone through by a number of people, but I think if the results only were published first and the full conclusions drawn from them were published later it would be of very much greater service to the industry in general.

The Chairman: I am now going to ask a gentleman from the other side of the Atlantic to speak to us. You all of you know there is an American Commission over here at the present time settling with an English Commission certain questions of compensation which is to be paid to the inventors of aeroplanes which were used by our American Allies during the war. One member of that Commission is Commander Holden Richardson. But he has another claim to your attention besides being a member of that Commission, and that is that he is, I should imagine, almost the only man in this room who once spent 60 hours in the Atlantic.

Commander Holden C. Richardson (United States Navy): Mr. Chairman and Gentlemen: My first word is to thank you for the privilege of attending this meeting, and of listening to the very excellent papers that have been read and the discussion which has been presented. I propose to make a few remarks on Mr. Fairey's paper, in which I am particularly interested.

As we have heard, I spent a little time in the Atlantic on a 'plane once. It was the N.C.3. We have had an illustration in Mr. Fairey's paper of the N.C.4 hull. That hull touches on research, because it was designed as the result of research in the model basin at Washington. The original design of that hull would have been an entire failure, but by certain modifications, which were derived from model basin experiments, we were able to improve the design so that we ran 30 per cent. easier than we otherwise should have run, and the Atlantic flight came within the realm of possibility. There was considerable discussion as to the merits of the design after the model basin test. We felt confident it would work, though I must confess I was rather scared when I first saw the hull in the factory. As a matter of fact the criticism was made that it was not

* Note by Sir R. Glazebrook: In this connection it has been pointed out to me since the meeting, that to meet this difficulty the margin of strength allowed for safety has been made very large.

going to be a success. However, it did succeed in doing something.

The three 'planes that started across had a varied experience, and in the particular aeroplane in which I was, what happened was this. I do not mean to tell you the story of the trans-Atlantic flight, but I want to tell you about the seaworthiness of the 'plane. We got into a storm, and landed on rough seas, and our landing was badly made; one of the other 'planes succeeded in landing under the same or worse conditions without any damage to the hull or wings. In our landing we landed very hard, and the wings were so damaged that we had to remain on the water, but we were able to travel through the storm for 55 hours and make port. During that time the seaworthiness was very thoroughly tested. Some light was also thrown on the question of the shape of the hull as a result of that experience. I do not think we should again build a short tail hull without any buoyancy abaft the stern post, because there were times when the sea almost came up over the stern post, and in drifting we found that would not be a nice thing to do again.

Mr. Fairey has mentioned the different types of float, the twin float and the single central float of the two-step and of the intermediate type, and I cannot altogether agree with his conclusions. But I can agree with his general conclusion that the boat type offers probably the greatest opportunity for going into commercial work with a very large plane. It certainly seems to me that the large seaplane has an opportunity of handling loads that it would be almost hopeless to attempt to handle from an aerodrome. At one time in the States we thought 45 miles per hour on the water was the limit of speed that we dare strive for. I think the limit to-day is more nearly in the neighbourhood of 70 miles per hour, and I would not be surprised to find it even considerably higher. As a matter of fact, if you are getting off on smooth water, the limit is almost what you want it to be. In rough water the conditions would be different, and I recognise the valuable contribution Mr. Fairey has made in producing higher-lifting wings that enable the 'plane to get off without severe punishment.

This subject is full of controversy—we have plenty of it in the States, and I notice you have it here—as to whether it should be the twin or single, or whether it should carry a tail and so forth. Commander Bird has referred to the necessity of taking these 'planes and trying them out under various conditions, and I certainly hope that that can be arranged, because these controversial matters cannot be settled without some such trial. We once had a controversy about twin floats; we had been working single floats up to that time, and a final proposal was to build twin floats to prove they were no good, and the wretched things went finely.

Here is a real problem. It is connected with research, and it is connected with design, and I really think that research is one of the most important things. I fully agree with that view of research, but I also believe that experience in the service is also extremely important, and that we cannot very well decide that a 'plane is good or bad if we only build one of them. They have to be put into service, to be tried under service conditions; and then we have to have accurate reports of what has been accomplished, and of what is wrong and what can be improved. If those reports are made, I feel that the engineers can solve the difficulty every time.

Commander Richardson.

Brig.-General R. K. Bagnall-Wild, C.M.G., C.B.E., F.R.Ae.S., M.I.Mech.E., M.I.A.E. (representing the Institution of Automobile Engineers): Mr. Chairman and Gentlemen: Sir Geoffrey Salmond's paper on research is of very great interest to the whole of the automobile world. I think it is hardly realised how closely akin are the commercial problems in aviation to those of automobilism. If you take the simple parallel, you have in the automobile world your racing engine, your motor-car engine, and your van or lorry engine. You have exactly the same thing in aviation in your single-seater fighter, your bigger fighter, and your commercial engine.

I want to put before you to-day the proposition that there is possibly a much greater relationship between the commercial aviation engine and the lorry engine than most of us think. There are many points in common, and in fact to-day the aircraft people are using those 10 standard steels which were originated by the Institution of Automobile Engineers.

I know time is very short to-day, so I will simply sum up with this request: that there be very much closer co-operation between the various institutions dealing with aeronautics and the Institution of Automobile Engineers. I feel sure that when the automobile engineer is designing his engine he would gain much by taking a leaf out of the aircraft engineer's book, especially with regard to engines, and it is the same the other way round. Therefore I suggest to the Air Ministry that they should devise some better system of co-operation between the institutions on both sides, because I think much benefit might then be derived.

Professor B. Melvill Jones, A.F.C.: Mr. Chairman and Gentlemen: I propose to talk upon the question of safety in flight. In the various papers that we have had and in the speeches that we have listened to this morning, we have seen great emphasis put upon the question of safety. I, for one, am entirely in agreement in putting that emphasis there. We, of course, have heard—and I am very glad that we have been able to hear it—the extraordinarily good results that have been obtained from the safety point of view during the last year, but I do not think we can rest satisfied with that; experience has not been, of course, very great. The type of safety that we require for commercial aeronautics is the type of safety that we have in a train, and I do not think anyone would be so bold as to say that we have even approached that stage yet in the air;

until we do, I do not believe that we will make any very immense progress.

Many things conduce to safety, but at the moment I propose to deal with the question of the minimum speed at which an aeroplane will fly. Everybody in this room knows, I imagine, that an aeroplane has a minimum speed at which it can fly, that the higher you can make the minimum speed the less can you make the resistance at high speeds, and the smaller will the aeroplane be, and that both these factors tend very strongly in the direction of economy in flight. On the other hand, everyone knows that the higher the minimum speed the greater the danger in landing, especially with a forced landing. This is not only because the landing takes up a bigger space, but because of the increased kinetic energy which is possessed by the machine when the beginning of the landing takes place. What I mean is that an accident to a fast machine is much more serious than an accident to a slow machine.

We are all on common ground so far, and realise that we are up against a compromise. All designers know these facts, and they nearly all begin to design by setting out to decide what will be the minimum speed at which the machine will fly, and in making that decision they have to weigh economy against safety.

Now the point I am trying to get at is this. You can measure the economy that will result from a given increase in the minimum speed with the greatest ease. Anyone can predict—even I could predict—that it would be so many pounds sterling per flight, and you can bring out a beautiful figure of so many thousand pounds per year saved as a result of putting up the minimum speed say, 10 miles per hour. On the other hand, you cannot calculate the effect on safety. It is quite impossible to say that putting down the minimum speed to so many miles per hour will save so many lives per year. Human nature is peculiarly optimistic, and when any individual is faced with alternatives of this nature, one of which he can calculate and the other of which he cannot, his inevitable tendency is to plump for the alternative that he can calculate and of which he can be certain. But it does not follow that for aeronautics as a whole the individual decision will be the best decision taking everything into account.

Now we come to this: that the minimum speed has somehow or other to be settled, and, in my opinion at least, it will be inevitable that the individual will settle upon too high a speed for the particular operations that he wants to carry out. If that is really true, it is a very serious situation; it means that in our efforts to obtain economy we shall always be working with a commercial air service which is more dangerous than it need be. If the danger were a merely negligible quantity that would not matter, but if, as I think we are all convinced, the danger is one of the main things which keeps the man-in-the-street off the aeroplane, then I think we must realise that this is a very serious matter.

What can we do to remedy a situation like this? My suggestion—it is only my personal suggestion—is that it is necessary for the world at large to come to some conclusion as to the maximum to be placed on minimum speed; in other words, to decide how fast the stalling speed of an aeroplane is to be. We must come to that conclusion as a whole, and then lay it down and say that for commercial purposes, we shall not exceed this minimum speed.

I do not propose to presume to suggest whether it would be better for this to be done by meetings of the aeronautical people among themselves, or whether it should be laid down by the Government as part of the necessary requirements, before a machine receives an airworthiness certificate; but I do maintain that there is a necessity for something of this kind to be done. I quite expect to be torn to bits by subsequent discussion on this question, but I do not think anyone will disagree with me that it is one that needs serious consideration.

On the question of what that speed should be, I have not nearly sufficient nerve to say. I would only say that my personal opinion is that the minimum speed of flight should be below 50 miles per hour. There would not be much object in making it below 30 miles per hour, because if you brought it right down to 30 miles per hour you need not kill anybody. I know the tremendous difficulties there may be in bringing down the minimum speed, but it will have been noticed that the range I have suggested, tentatively as a basis of discussion, excludes most existing commercial machines. What grounds have I for adopting that range? Certainly they are not theoretical grounds. I defy anyone to settle this speed on theoretical grounds; it cannot be done. My grounds are purely personal experience, and therefore must only be taken as of that particular value. I have had a certain amount of experience of flying, not much as a pilot, but a great deal of experience as an observer behind some of the very best pilots the world has produced, and I know that a modern pilot would have no hesitation in taking a machine like the Avro, with a low landing speed of something like 40 miles per hour, over woody country with a rickety engine, that is supposing he had a rickety engine to contend with, and I would not mind going with him. The reason is that pilots know that if they are forced to land a machine of low landing speed they probably will not be killed whatever happens. There is, for instance, a pilot in this room who drove an Avro into a tree, and he told me quite happily that he looked at the tree and decided which was the best and softest place to hit; he knew that if he went too low he would hit the trunk, and if he went too high he would have a bad fall; and so he chose the best part of the tree to hit. If he had been in one of the modern Scouts, or one of the modern commercial machines, he would probably have been killed.

These are only personal opinions, and I do not want more weight given to them than is due. Really what I am trying to get at is that more consideration should be given to the question of safety, and that, in my opinion,

the minimum speeds, of existing aeroplanes are too high.

Still dealing with the question of safety I want to harp on the question I have mentioned before. I brought it up at the last Conference, I shall bring it up at the next Conference, and the next, until something is done about it. What I refer to is the fact that commercial machines are still not provided with turn indicators. It is definitely recognised now that the turn indicator is one of the most essential instruments for safety in machines which have to fly in bad weather. I do not propose to say any more about it. I know there have been great difficulties, but still I want to point out we have not got them on machines for commercial use, and it is of vital importance we should have them if we are to improve our safety.

The CHAIRMAN : I have one other name on the list of speakers who wish to take part in the discussion, viz., Sir Archibald Denny, of the British Engineering Standards Association. I will call on Sir Archibald Denny now, and then, I think, I may call on Mr. Handley-Page to say something in reply to what Professor Melvill-Jones has said.

SIR ARCHIBALD DENNY, BT. (Chairman of the British Engineering Standards Association) : Mr. Chairman and Gentlemen : I do not know that I can make very much contribution to the Conference from the technical point of view. That is not really the object with which I rise, except that in regard to the relation between model experiments and full-size experiments I can give the experience of forty years so far as ships are concerned. I can assure you that we have absolutely no doubt whatever we are able to predict accurately from model to ship, within one-half per cent. one might say. More recently we have dealt with model engine problems in water. There we have somewhat more difficulty, but gradually we are overcoming the difficulties, and now from our own experimental tank I can be pretty sure that within a few revolutions and within a small percentage of efficiency the full scale will follow the model. Therefore I think that those who are interested in model experiments with aeroplanes may take heart, and we may be assured that ultimately they will have the same confidence.

But my object in rising as Chairman of the British Engineering Standards Association was to thank Sir Geoffrey Salmond on behalf of my colleagues and the staff for his kind reference yesterday to the assistance that the Association gave to the Flying Services during the war, and subsequently. During the war my association was asked by Lord Weir to undertake the work of preparing the specifications which were so urgently needed, and for which work we received his thanks. General Bagnall-Wild will remember the occasion. We have since continued to do work for the Ministry and the manufacturers, which, I am sure, has considerably benefited commercial aviation, and at the present moment the secretary tells me we have 100 specifications in hand. We were founded in 1901 by the five great scientific Engineering Institutions, and we were warmly supported by the Government of that day. It will, therefore, be seen that this year our Association celebrates its coming of age. We have issued during these 21 years specifications in almost every branch of industry. At the present moment there are 2,000 gentlemen, consulting engineers, Government officials from all departments, inspecting engineers, representatives of the manufacturers of all descriptions of materials, and of the purchasers and consumers of those materials, working on those specifications, and working without fee or reward or even without their expenses, and that they do so I think demonstrates the value they put upon that work.

Yet in spite of this, and in spite of the fact that last year in this country alone we sold 40,000 copies of these numerous specifications, and in spite of the publicity which is given to us by our good friends of the Press, I find a considerable measure of ignorance as to what we are and what are our methods. Now, I would like to say that we only function when we are asked to do so by responsible bodies, and then only after having a conference of every one concerned, be it Government Departments, consumers, engineers, manufacturers or inspectors, and the result of the work is finally considered by the main Committee, a body of independent engineers of high standing. We supply, I think General Bagnall-Wild will agree with me, a forum where everyone interested can come and contribute their quota towards the good of the industry, and where all have absolute freedom to express their full opinions and requirements, and will have their interests fully considered.

I have to thank Sir Geoffrey Salmond for his kind reference; I have to thank you, Mr. Chairman, for allowing me to make these remarks; and I have, finally, the honour to make this offer : that my Association will welcome at all times useful work that may be placed upon their shoulders, but they will not initiate it unless they are asked.

MR. F. HANDLEY PAGE, C.B.E., F.R.Ae.S. : Mr. Chairman and Gentlemen : I would like thoroughly to agree with what Professor Melvill Jones has said, and at the same time thoroughly disagree with him. I would like thoroughly to agree with him on the necessity for slow landing speed, the subject which has been ably dealt with by Sir Geoffrey Salmond both in regard to the necessity for it as well as means for obtaining it. But in regard to turn indicators I am afraid Professor Melvill Jones is hardly up to date, in that they are at the present time in use. We ourselves have tried three different types, and the difficulty is less in the turn indicator itself than in the actual use of it. I hope that between now and the many conferences that Professor Melvill Jones hopes to attend and to bring up the subject, he will give us the benefit of his help and assistance at

Croydon, which I am sure will be very much welcomed.

There is just one point in Mr. Fairey's paper, that I would like to refer to. I notice that in comparison between flying boats and aeroplanes, he says that the structure weight of aircraft mounts very rapidly with increase in size, but that there is a corresponding diminution in the flying boat. That curve is obtained by taking two machines of our own type, the structure weight of which are 12,500 lbs., about 37 per cent., and 24,000 lbs., somewhere about 38 per cent. The actual official figures, I believe, are 34 and 31 per cent., and if, instead of the last figure of the curve, the 38 per cent., we put down 31 per cent., I think Mr. Fairey will find that the shape of the curve has considerably altered, thus rather knocking the bottom out of his argument as to the great advantage of the flying boat over the aeroplane.

The Chairman: Before I ask Sir Geoffrey Salmond to reply, and also Mr. Fairey and Col. Ogilvie, I will just ask Sir Sefton Brancker to say a word on landing speed.

Major-General Sir Sefton Brancker, K.C.B., A.F.C. (Director of Civil Aviation): Mr. Chairman and Gentlemen: I do not want to enter upon a discussion on landing speeds, but I cannot let Professor Melvill Jones' comment go by unchallenged. At present one of the few things that aviation can give you—though it is going to give you everything in the future—is speed, and I very much deprecate the great agitation that comes from a good many quarters about the value of very low landing speeds, even at the expense of flying speeds. The cure for that is not to have engine failures; we should not have them, and we do not have them in properly run shows even to-day. The Professor mentioned a pilot who had a forced landing and hit a tree. Well, we had two forced landings in the last few months which should not have occurred as they were perfectly avoidable; both the machines hit trees and yet no one was scratched although they were high speed machines.

A much more difficult problem I think for the designer is a machine which will get out of a place when heavily laden without any danger of running into trees and houses at the opposite end of the ground. I do not like this doctrine which is being preached that safety lies in a low landing speed, because honestly, I do not think the statistics bear that out at all. You cannot put your finger on any serious accident which has occurred for a very long time that can be attributed to a fast landing speed. We do want speed; speed is most important both from the economical point of view and from the advantage which we are going to give the public, and for fighting against bad weather.

Mr. Handley Page, I think, supported Professor Melvill Jones with regard to low landing speeds, but I cannot resist having a "dig" at him. He happens to have a rather slow machine, and I regret to say that, as the subsidies we are giving at present are based on payment for flights to Paris which do not exceed four hours, we have had in the last few months to cut some of his flights because they have very considerably exceeded four hours' flying. That is no good to anybody; if we cannot fly to Paris within four hours we had better shut up shop. That is what I mean by the advantage of speed.

I agree with Mr, Handley Page as regards the turn indicator. I am the official who has his finger ready to press the button and say that a turn indicator is absolutely essential and that you may not fly without one; but I cannot get a turn indicator that will work. That is the trouble. They may work well with a real scientific expert looking after them, but they do not work with the ordinary practical pilot. I am only too anxious for a satisfactory turn indicator, and I am waiting for it to come. No one realises more than I do its value. and how much it is going to help us, but the scientist has to give us a practical working turn indicator before we can insist on its use.

Air Vice-Marshal Sir W. Geoffrey H. Salmond, K.C.M.G., C.B., D.S.O. (Air Member for Supply and Research): Gentlemen: Professor Bairstow very kindly referred to my paper and quoted my remark about "research knowing no horizon." I am very conscious of the fact that there are many milestones stretching out towards that horizon, and I want to let everybody realise that I so thoroughly appreciate that point. In the paper that I read yesterday I have since been rather stricken as regards my conscience because although I told of a lot that had been done I did not talk very much about what had been left undone, and, of course, there are many many things which are only one milestone ahead which have yet to be done, and which I hope we will really tackle during the present year.

We have not succeeded in the question of evolving a satisfactory gear for the multi-engine machines. We have not succeeded in the question of the aerodynamical qualities of the thick wing, but we are progressing, and I hope very shortly that we shall produce some result. I do not think we have succeeded in our investigations as regards all-metal aeroplanes in getting an all-metal aeroplane which will be an economical machine to produce, but, as I said yesterday, I think we shall get it because this year we are going to pay special attention to it.

There are many other things. We have not perhaps evolved a perfect turn indicator, as has just recently been brought home to us; but I want you to realise that we are only too ready to accept suggestions on lines of improvement.

Before I go any further, I would like to say, in my capacity of supplying the requirements both of the Director of Civil Aviation and of the Service, that my department does its utmost to satisfy both, and that they are intimately tied up with one another.

What struck me most as a result of the discussion this morning was that, however much may be talked on civil aviation and on the difficulties in getting it forward, it all comes down to research. We cannot get away from it. Safety, reliability—

that was the burden of the message this morning!

Now under safety, I take it that one of the prime things we have to tackle is the ability to land in a confined space. We have heard to-day of the experiments that are being made in flying below the stalling angle; in other ways, safety has to a very large degree been achieved. The difficulty is to get the public to know it. It is only in certain particulars that it has not been achieved, and unfortunate accidents that have nothing to do in a sense with civil aviation loom up largely in the public eye and the public get affected. The first index that will show us that the public are recognising the fact that safety has been achieved will be in the lowering of the insurance premiums, which we heard to-day is gradually coming about.

But I must say that as far as research is concerned it appears to me that if we tackle this question of ability to land in confined spaces, and if we can solve the question of controllability below the stalling angle, we shall have gone a very long way to help civil aviation, because things do happen which often make a landing necessary.

The other point as regards reliability which we have not solved but which we will tackle as seriously as we possibly can, is the ability to land in fog. I think it is the biggest problem, in a sense, that we are up against. It is extremely difficult, but I would like you to know that there will be the fullest efforts made to try and tackle this question.

The third point as regards civil aviation will be to try to solve the question of cheap production of civil machines, especially metal machines. Again we have been waiting for opportunities of development of the three-engine machine, whereby if one engine fails two engines will be sufficient to carry the machine on to a landing ground. That question will be coming forward during the coming year, but as General Brancker told us the cases of engine failure have been practically non-existent during the past year.

With regard to the further development of what is required in civil aviation I hope we shall get enormous help from the sub-committee of the Aeronautical Research Committee, which is a result of the Civil Aviation Advisory Board's recommendation. What their recommendations will be it is hard to say, but I hope they will tackle for us the question of fog, metal machines, and production from a civil point of view.

Another thing that I think wants to be tackled is the production of a cheap commercial engine about 450 h.p., not so light as the Service engines, but one which will give the reliability which General Brancker wants; that is to say, an engine which it will not be necessary to overhaul below 1,000 hours. That, of course, will reduce maintenance costs, which is one of the things we want to work for.

All these things come into the province of research. Another matter that everybody has talked about is noise. I told you that the noise from exhausts has been solved, but we have not solved the question of propeller noise, or noise of the moving parts of an engine, and I most thoroughly appreciate the point which General Seely made that noise is a very important factor as far as the pilot is concerned.

Mr. Handley Page referred to the possibility of the allotment of funds to commercial firms for carrying out research, and he quoted a question about fog. I hope that this new sub-Committee of the Aeronautical Research Committee will help us as regards this question of the solution of the fog problem, but generally I think it would be well, since we have so little money available, if the efforts could be centralised. The channel now, however, exists by which the wishes of the aircraft constructors as regards this particular point of research can be really brought to light.

With regard to parachutes, of which mention was made this morning, the question of the provision of parachutes for the service has never been dropped, and it is still being pressed on, but we have not evolved what I may call the 100 per cent. parachute. We have the 95 per cent. parachute, but we have not got the 100 per cent. parachute. The parachute is a thing which we do not like to issue to the service unless it actually came to war, until we have 100 per cent. efficiency; that is to say, that if it is dropped from a machine under any circumstances it will certainly and without doubt open out and so save the pilot. Experiments have been going on continuously at our experimental establishments, and three types of parachutes are under experiment. Certain of them have been issued to training units, and every new machine of new type that is now produced for service has provision in it made for parachutes. The parachute is coming, but it has not completely arrived.

As regards what Major Green said, we cannot quite afford to leave out gliders in our research programme, because we do not quite know what the possibilities of gliders are.

As regards the results of research being made available by interim reports, I will go into this question, but we are very loth to mislead, and I think it is possible that we might mislead unless we are very careful.

With regard to what was stated by Commander Richardson and Commander Bird about floats and boats, we have tried to bring off a comparison between boats and floats this year, but unfortunately one of the machines had a serious accident just before the experiments took place and we were not able to carry out the comparative trials which we all want so much. I hope, however, that during this year we shall be able to do so. I quite agree that it might help us to come to some decision upon the matter, but I am afraid that any decision which we may reach as to their relative merits may not necessarily be applicable to service requirements. I cannot go into them; but there are difficulties with regard to service requirements which might interfere with any decision in favour of the universal adoption of either the boat or the float type.

Sir Geoffrey Salmond.

With reference to what Professor Melvill Jones said about minimum landing speeds, it is very curious and interesting to bear in mind General Brancker's remarks that aeroplanes are made for speed. The other day I was talking to a very distinguished foreigner about this question of landing speed, and he was most emphatic on the point that aeroplanes were made for speed, and that the question of landing speed must not be overstressed. He said that when he considered the construction of an aircraft he thought of the landing speed last because aeroplanes were made for speed and the engines ought to keep them up. They, therefore, ought always to be able to find a landing ground to land on.

However, it has been explained that we are trying to discover how to fly a machine below the stalling angle. I do hope that with a compromise between that and what Professor Melvill Jones asks for, we shall get something which is really satisfactory.

In conclusion I would like, as I said before when I opened the paper, to thank all the organisations for the very able assistance they have given us during the year in trying to get ahead. The responsibility of the Research Department for the future welfare of aviation is really tremendous, and I hope we shall not fail in any respect.

Mr. E. R. Calthrop: May I make one statement with regard to Service parachutes, especially with regard to the 100 per cent. parachute which Sir Geoffrey Salmond was speaking of. Are you aware that over 18 months ago I submitted two entirely new parachutes to the Air Ministry and I was told that the Air Ministry had neither the men nor the money nor the machine to make the test.

Sir Geoffrey Salmond: I think there has been an actual promise made in Parliament that the parachute will be finally adopted when we have an absolutely satisfactory type, but it would be wrong of me to say that our experiments have proved that parachutes as they exist at present are absolutely safe. The high speed aeroplane in particular is one which produces great difficulties in the release of the parachute. I had not actually heard of the facts that Mr. Calthrop has stated just now.

Mr. Calthrop: One of those parachutes submitted was precisely for high speed flying.

The Chairman: There is no doubt Sir Geoffrey Salmond will take note of what you have said.

Colonel Alec Ogilvie, C.B.E., F.R.Ae.S.: With regard to the remark which General Brancker made about engine failure, I think that his idea that you can get complete reliability of an engine is a mistake; if that is really firmly fixed in his mind I think he is wrong, and I do not think there is any doubt that 90 per cent. of the people in this room think so. Certainly the whole of the research workers as far as I know are definitely of the view that it is impossible to rely upon complete reliability of the engines, and that it is a mistake to think that you can have an indefinitely high landing speed with that in view.

The only other point I should like to comment on is the question of tenders by the Government. It appears to me that it would be far more desirable if the tenders could come from the transport firms to the aircraft manufacturers direct. I do not know whether it is really necessary now, but the suggestion that it is satisfactory for tenders for machines to be issued by the Government is not really correct. What we wish is for the users themselves to say what they want to the man who is going to make the machine.

Mr. C. R. Fairey, M.B.E., F.R.Ae.S.: Mr. Chairman and Gentlemen: In view of the controversial nature of the points I raised in my paper I think I have got off very lightly. In any case you have probably noticed I was most careful to leave myself an avenue of retreat if I was too vigorously attacked on any one point. So that in answering any points raised I wish most particularly to say that I do not do so from the point of view of taking any side in the controversy and justifying one type against the other. I can imagine no more disastrous attitude of mind for any designer than one of bigotry. Therefore I only pointed out that the average advantage accrued to one type in certain sizes, and to another type in others. The line of retreat that I left myself was that if any one requirement was preferred then that type could alone fulfil it. I quite agree with what all the speakers on the question have said, that both types must inevitably survive.

Now without advocating either type I should like to comment on one or two of Commander Bird's points to begin with. In the first place as to the question of high central thrust in a boat, I agree it may be got over; it is only a matter of negative load on the tail; but when you consider a load of the order of 1,000 lbs. at the height of four or five feet, it is obvious that it is an enormous one to deal with. I do not dispute that the stability can be put right; I point out the cost at which it is purchased.

As regards the other point of puncturing a hull, the same applies to the floats to a much less extent. The bulkheads can be made throughout the length of a float quite watertight, but if you were to dispose of gear, cockpits, petrol tanks and other things, you cannot make a watertight bulkhead with reasonable safety much forward of the main planes.

There are only two other points I want to raise. I very much welcome Commander Richardson's contribution to the Conference, but I fail to see on what point I disagree with him. The peculiarities he instanced of the N.C. 3 type were what I endeavoured to point out, namely, that this class are superior for taking off, but are not so good when adrift in a sea wave. The particular point I endeavoured to make was that the safety of a machine at sea is entirely different when the engine is running and when the machine is adrift. In every case the designer is forced to a compromise between the two extremes

Then on the question of structure weight, this was the curve on which I most expected to be criticised. I stated most carefully that the results when plotted, I think I used the expression, were more like a cloud of dust than a curve. It is only natural if you take a great number of points that they should be widely scattered. What I endeavoured to take in arriving at that structure weight was the general average density. The authorities from which I got the information were mostly official, the Aeronautical Journal, and the official published lists of various machines.

As to Mr. Handley Page's particular contention I may quote the following figures. According to the 1919 record of the larger machines for commercial purposes, the structure weight given was 46·8; seeing I have taken under 40, I think I have struck a fair average; in the case of the smaller machines the structure weight in the Aeronautical Journal is given as 37 per cent. Now with regard to what Mr. Handley Page had to say as to the possibilities of the other point altering the shape of the curve, I would point out that if I took those points it would make a very considerable alteration but in the reverse direction. My contention is this. You can alter the curve up and down, you may be as optimistic or as pessimistic as you like, but with either class of machine you cannot alter the shape. That is my case. For quite obvious reasons—and it is perfectly reasonable when you think of it—those curves take opposite lines of advance. If you put floats on a small Scout aeroplane you are committing a perfect outrage structurally, and the structure weight must go up. All machines show to advantage round about 5,000 or 6,000 lbs., and when you consider the tremendous number of designs made at that weight in comparison with larger or smaller machines the advantage of experience is shown. An aeroplane I consider must go up in weight with big structure sizes not only for the law as regulating to the wings, but for reasons of the increased weight in the completion of the fuselage and chassis. The flying boat naturally will not go up so fast, but I do not say it will continue to come down, because the larger you make the hull and the less buoyant, the greater the proportion of weight. It was there I tried to make the whole case for the seaplane.

The distances from point to point round the world which we wish to travel were not apparently placed with any consideration of the natural limitations of aeroplane design. We have still for the moment about 2,500 miles as the natural limit of range. Until we get a vastly different aerofoil or a different engine we shall not alter that much. The Pacific Ocean and the Atlantic Ocean in many senses are much too wide unless we increase that range. There is a prospect of doing it, but the larger you build the aeroplane the less, apparently, the range will have to be. On the other hand, for the time being in slightly larger sizes the bigger you make a seaplane the less the structure weight, and the further it can fly. That was my case for the seaplane as such.

Mr. Fairey.

The CHAIRMAN : Gentlemen, that concludes the Conference, which, I think you will all agree, has been a most successful one. Before we separate I want to ask you to pass a vote of thanks—and I am sure it will be unanimous—to the Lord Mayor and the City Corporation for their kindness in lending us this hall. I myself have very great pleasure in moving the vote of thanks from the chair—an ancestral pleasure I may call it, as for some generations back my family have been active members of the City Corporation. I am sure you will take it from me in the chair, and as not requiring any seconder. Will those who agree, please show? (Carried unanimously.)

I have no doubt the Secretary will communicate that expression of thanks to the Town Clerk. That concludes the business of the Conference, and I now have only to venture to express the hope that next year's Conference will be as successful as this one, and that we shall all meet again another year.

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ILLUSTRATING MR. FAIREY'S PAPER ON SEAPLANES (pp. 72–85).

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By Eyre and Spottiswoode, Ltd., East Harding Street, E.C. 4,
Printers to the King's most Excellent Majesty.

EFFECT OF CONTROLLING ATTITUDE OF FLOATS IN "TAKING OFF."

COMPARISON BETWEEN SINGLE & DOUBLE STEP TYPES.

EFFECTIVE HORSE POWER WITH ATTITUDE OF FLOATS UNCONTROLLED.

5200 LBS. DISPLACEMENT.

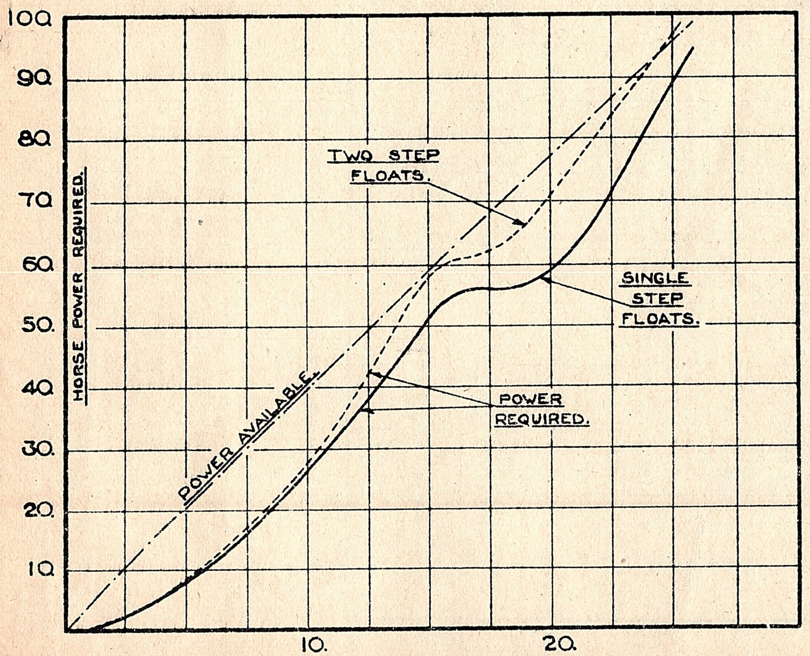


FIG.1.

EFFECTIVE HORSE POWER & MOMENT REQUIRED WITH ATTITUDE OF FLOATS CONTROLLED.

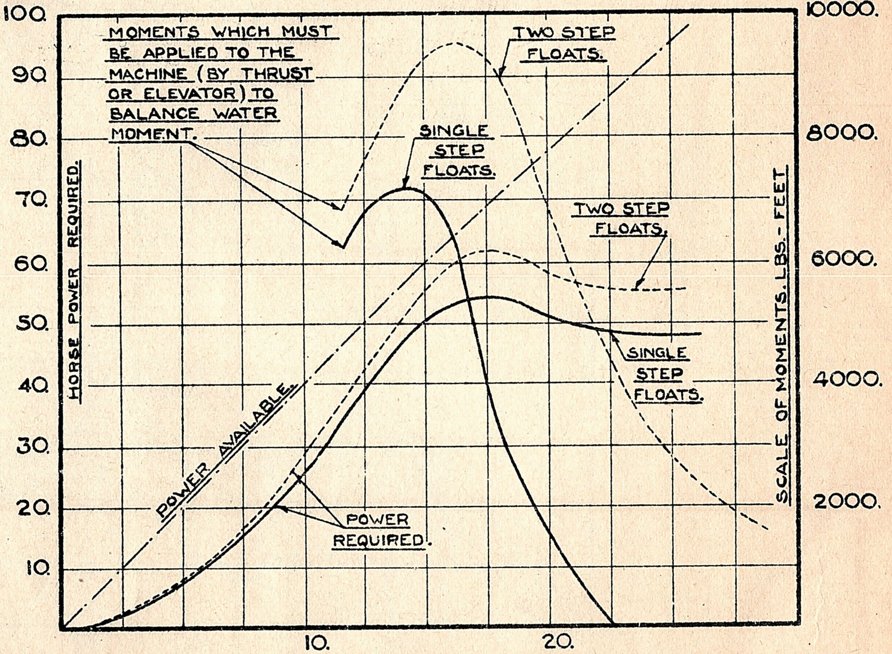


FIG.2.

28847/8524.1125.4/23.

C&R.LTD 1023.

COMPARATIVE PERFORMANCES OF AEROPLANE, SEAPLANE & FLYING BOAT.
OVERALL WEIGHT 5200 LBS. IN EACH CASE.

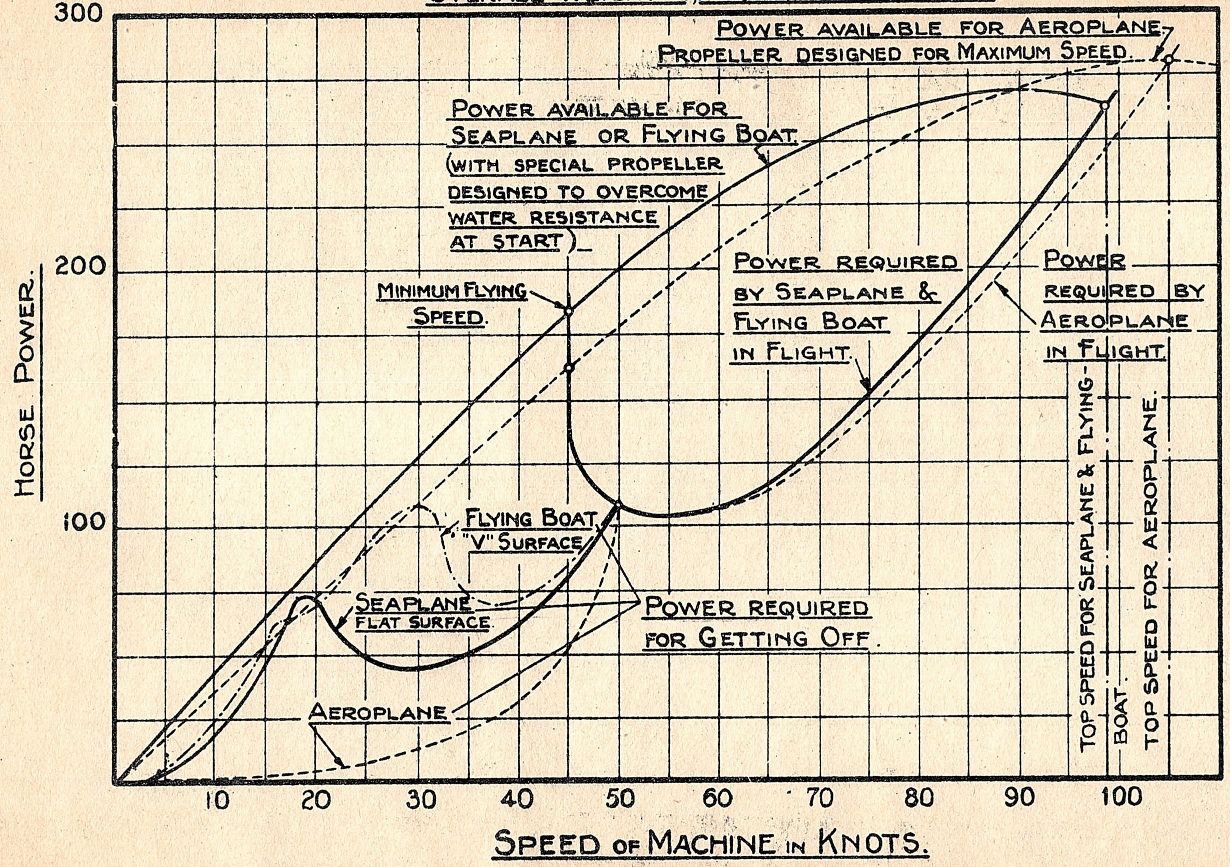
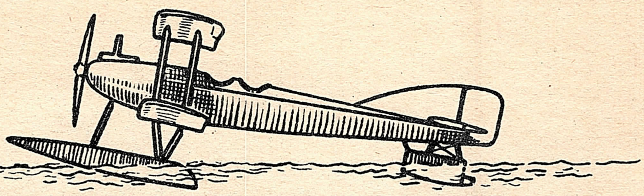
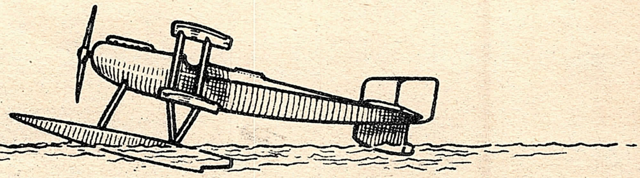


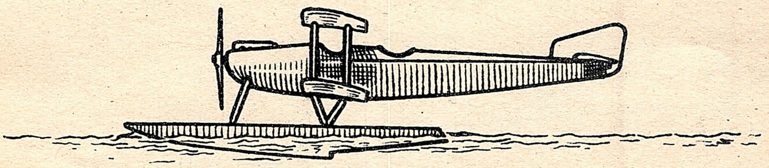
FIG. 3.



SINGLE STEP TYPE. HEAVILY LOADED TAIL FLOAT.

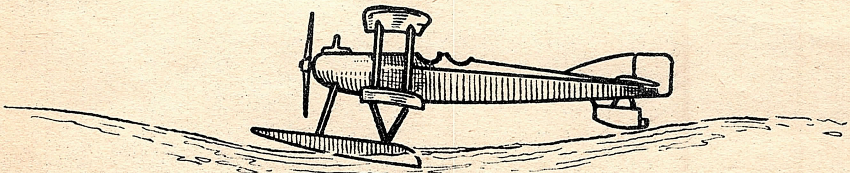


INTERMEDIATE TYPE. LIGHTLY LOADED TAIL FLOAT.

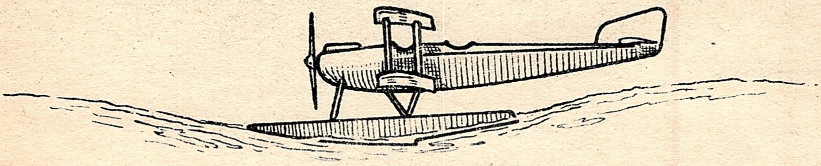


2 STEP TYPE. NO TAIL FLOAT.

"TAXYING".



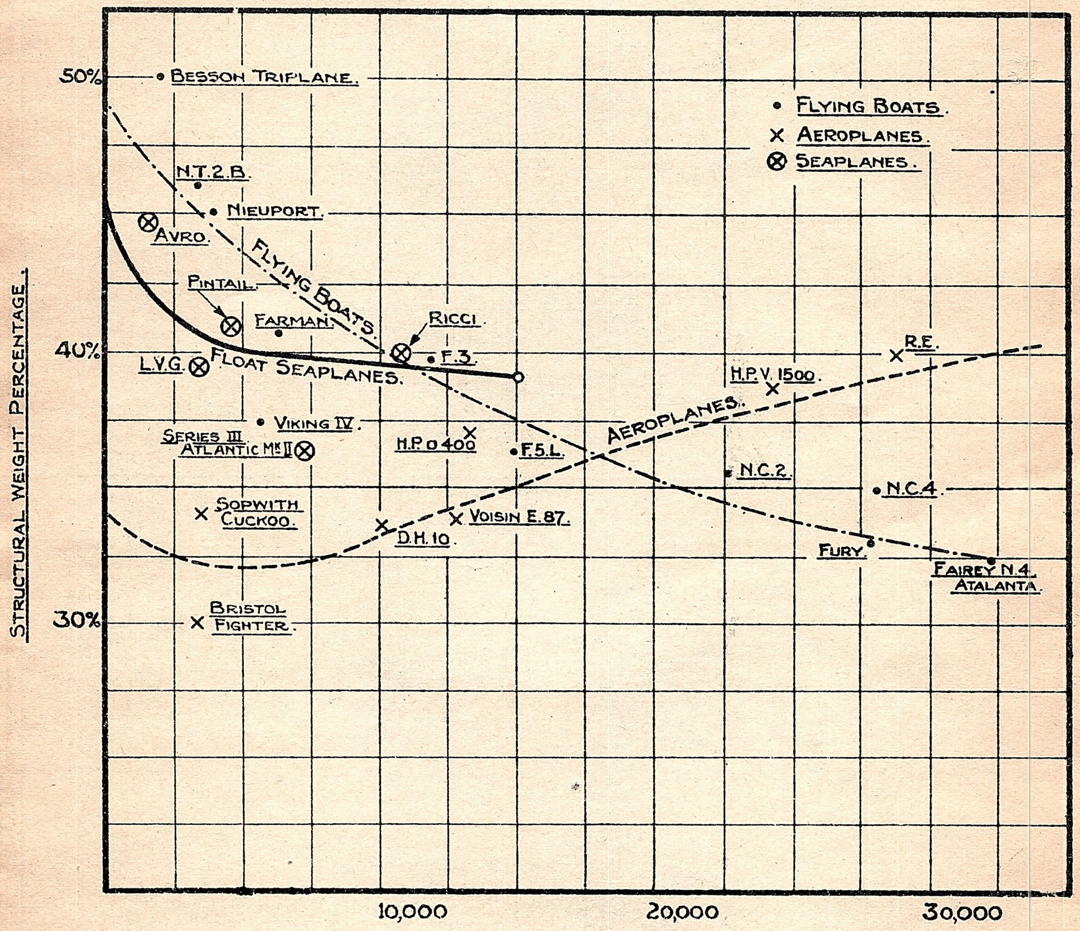
SINGLE STEP.



TWO STEP.

FIG. 4

COMPARISON OF STRUCTURAL WEIGHT PERCENTAGE FOR AEROPLANES, SEAPLANES & FLYING BOATS.



GROSS OVERALL WEIGHT IN LBS.

FIG. 5.

VARIATION OF STRUCTURAL WEIGHT. WITH TOTAL DISPLACEMENT.

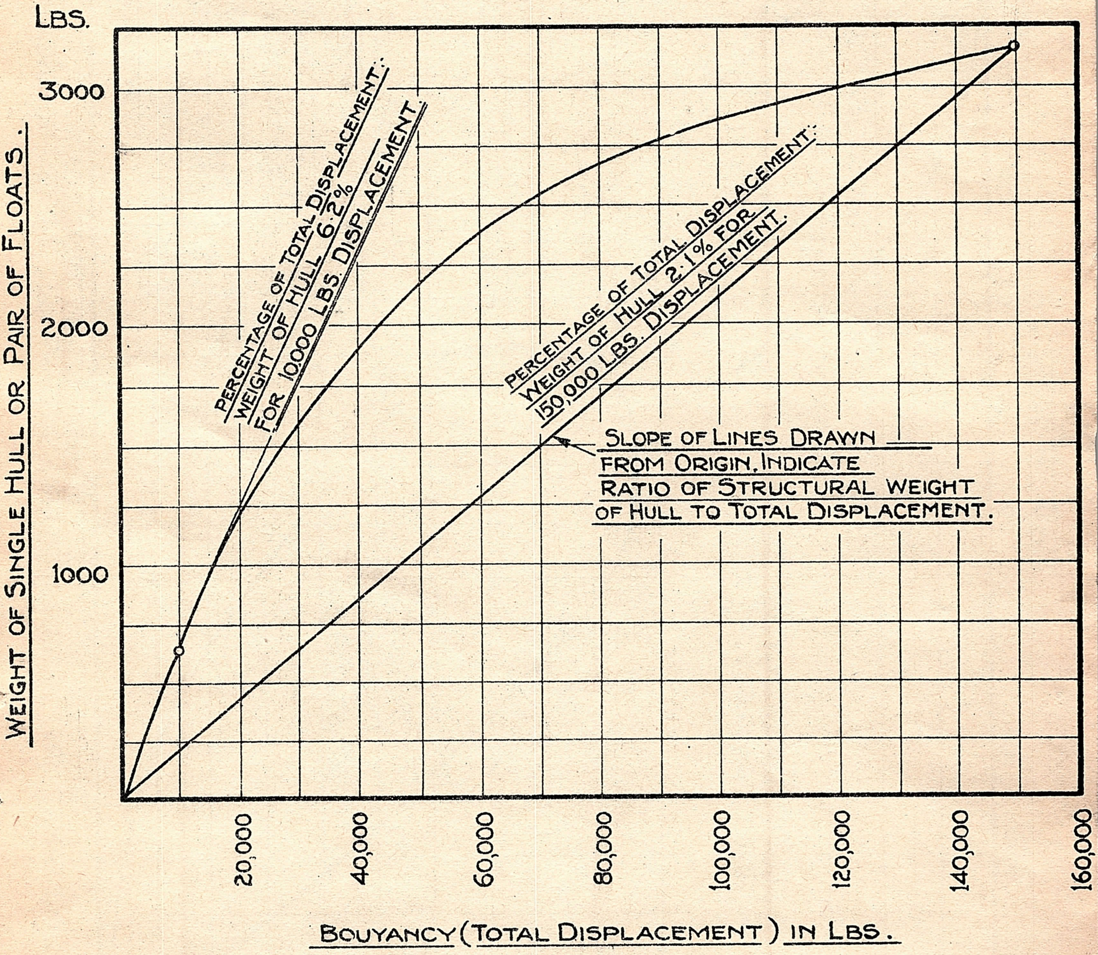


FIG. 6.

Comparison of Performances of Large Aeroplane and Flying Boat.

Useful Load carried 9,000 lbs. for Both Machines.

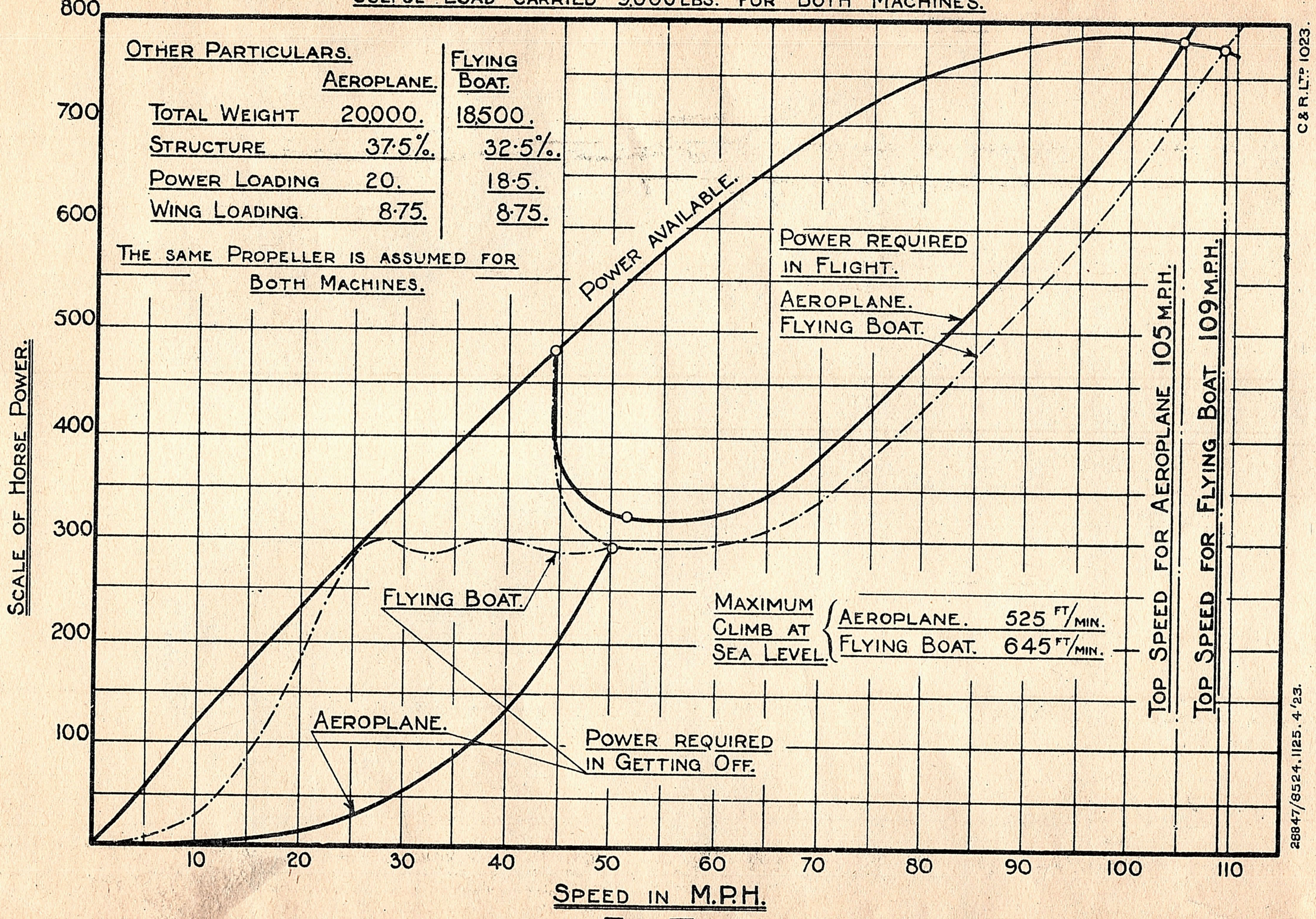
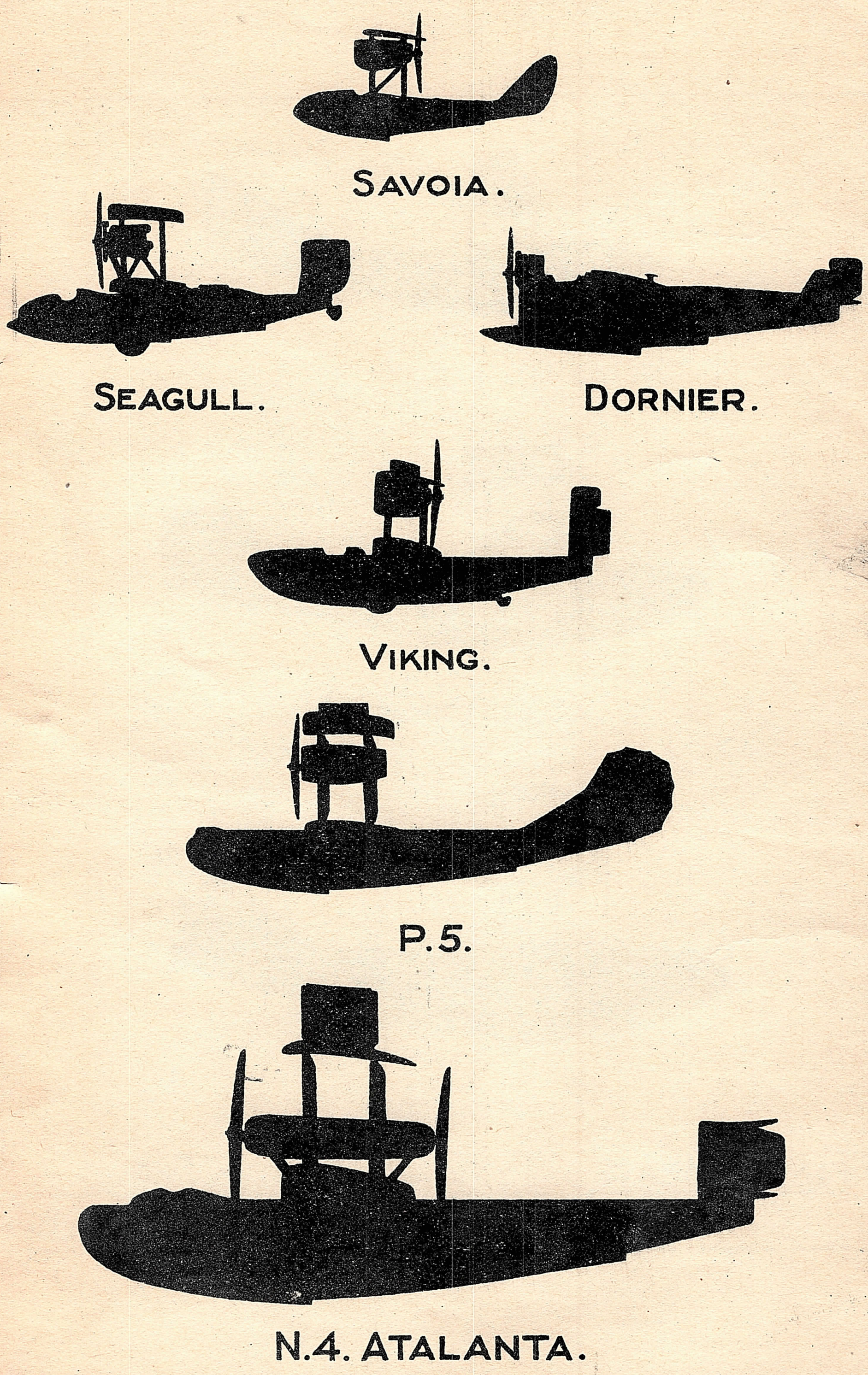


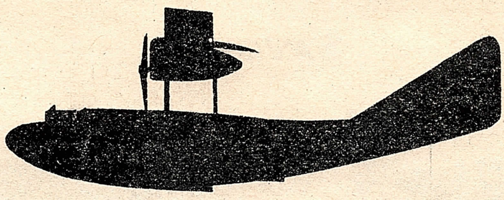
Fig. 7.

28847/8524. 1125. 4/23.
C & R. Ltd. 1023.

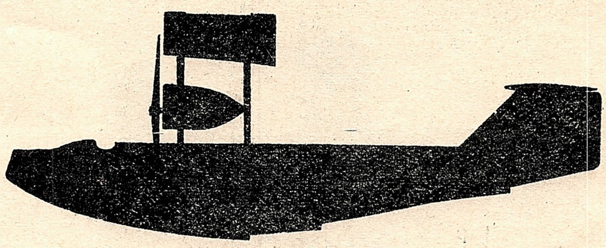


FLYING BOATS - TYPICAL 2-STEP TYPES.

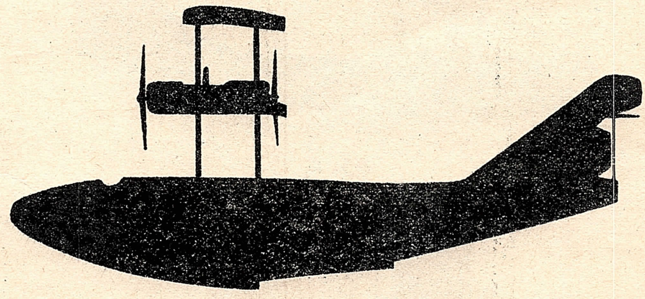
FIG. 8.



F.3.



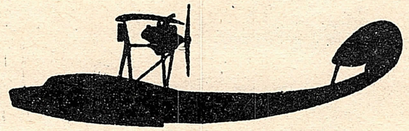
SHORT "CROMARTY".



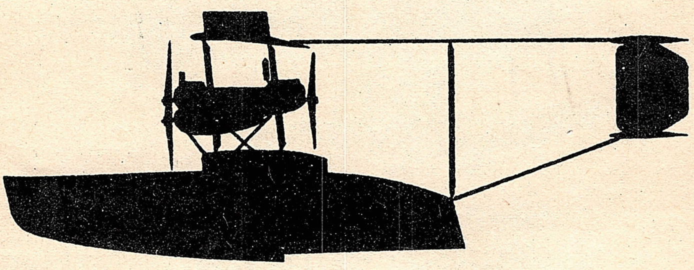
"FELIXSTOWE FURY."

FLYING BOATS - TYPICAL 2-STEP TYPES.

FIG. 9.



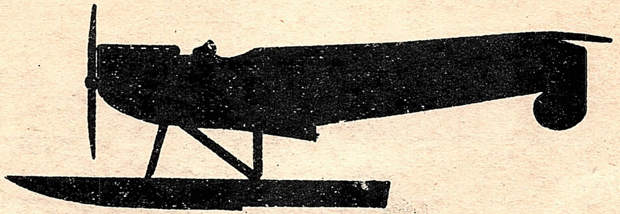
FARMAN.



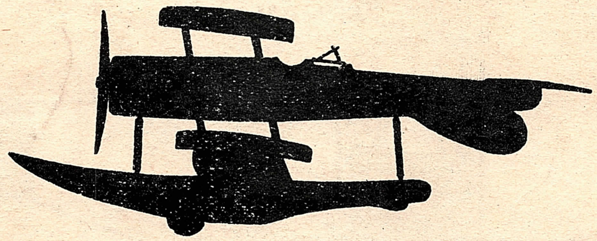
N.C. 4.

FLYING BOATS TYPICAL 1-STEP TYPES.

FIG. 10.



INTERMEDIATE STABLE TYPE.
BRANDENBURG.



SINGLE FLOAT TYPE.
PARNALL PUFFIN.

INTERMEDIATE SINGLE FLOAT TYPE.
U.S.A. NAVY PLANE.

FIG. 11.